Vol. 11, No. 17
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Energy Research Abstracts

Abstracts 37258-39446

Office of Scientific & Technical Information
UNITED STATES DEPARTMENT OF ENERGY

CURRENT AWARENESS PUBLICATIONS ON ENERGY

To provide complete coverage of literature related to major Department programs, announcement publications that are comprehensive in their coverage of certain energy fields are issued regularly. All information in these publications, plus additional backup information, is included in the Energy Data Base of the Office of Scientific and Technical Information; all references are also available for machine searching via the on-line retrieval system, DOE/RECON, and the commercial on-line retrieval systems. Descriptions of these current awareness publications, which are supported either directly or indirectly by the DOE, appear below. Department of Energy components may receive the listed publications free from the Office of Scientific and Technical Information, U. S. Department of Energy, P. O. Box 62, Oak Ridge, TN 37831. Telephone (615) 576-1301; FTS 626-1301.

PUBLICATIONS OF THE OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION

Energy Abstracts for Policy Analysis (EAPA)

A monthly abstract journal devoted to the analysis of energy research, conservation, and policy. Scope and coverage are limited to substantive articles or reports and emphasize legislative, regulatory, and other legal aspects, as well as social, economic, and environmental impacts. *EAPA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The annual subscription price is $72.00 for domestic (North America) or $90.00 for foreign (outside North America) subscribers; a single issue is $5.00 or $6.25, respectively.

Energy Research Abstracts (ERA)

A comprehensive semimonthly abstract journal devoted to all areas of energy-related information produced by the Department of Energy, other U. S. government organizations, and foreign governments. *ERA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The annual subscription price for the 24 issues is $146.00 for domestic (North America) subscribers or $182.50 for foreign (outside North America) subscribers. A single issue is $14.00 or $17.50, respectively.

DOE Patents Available for Licensing (PAL)

DOE is prepared to grant exclusive or nonexclusive, revocable licenses under DOE-owned U. S. patents and patent applications; this semiannual publication provides abstracting and indexing coverage of this literature. *PAL* is available (use PB86-946800) from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The annual price is $18.00 for domestic (North America) or $36.00 for foreign (outside North America); a single issue is $9.00 or $18.00, respectively.

Energy Meetings (EM)

A monthly listing of conferences, symposia, workshops, etc., pertaining to DOE's programmatic interests. *EM* is available on subscription (use PB86-901500) from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The annual subscription price is $45.00 for domestic subscribers and $90.00 for subscribers outside the North American continent; a single issue is $5.00 and $10.00, respectively.

The following monthly update journals are available to the public on subscription from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; use the identifying order number (PB- No.) when subscribing. The annual subscription price (12 issues plus cumulative index) is $85.00 for domestic (North America) and $170.00 for foreign (outside North America) subscribers; a single issue is $8.00 and $16.00, respectively.

***Current Energy Patents (CEP)*–PB86-902800.** International patent literature, including patent applications, on any aspect of energy production, conservation, and utilization.

***Energy and the Environment (EAE)*–PB86-914900.** Impacts of energy-related activities and radioactive and nonradioactive pollutants on the environment.

***Fossil Energy Update (FEU)*–PB86-914600.** The exploration, development, processing, and use of fossil fuels.

***Fusion Energy Update (CFU)*–PB86-915300.** Information on controlled thermonuclear fusion, including plasma and fuel research and power plant engineering and conceptual design studies.

***Solar Energy Update (SEU)*–PB86-914500.** The utilization of solar energy, including biomass and tidal and wind power.

The following semimonthly bulletins are also available from the National Technical Information Service. The annual subscription rate for one volume (calendar) year (24 issues; no indexes) is $45.00 for domestic (North America) and $90.00 for foreign (outside North America) subscribers; use the identifying order number (PB- No.) when subscribing.

***Acid Precipitation (APC)*–PB86-901000.** Acid precipitation, including effects and possible control measures.

***Buildings Energy Conservation (BEC)*–PB86-900700.** Technology required for energy conservation in buildings of all types.

***Coal-Based Synfuels (CBS)*–PB86-901400.** Conversion of coal into gaseous or liquid fuels.

***Coal Combustion and Utilization (CCU)*–PB86-914400.** Coal combustion, including fluidized bed combustion, and direct utilization of coal for power generation, fuel cells, and MHD generators.

***Coal Preparation and Pollution Control (CPC)*–PB86-900800.** Coal preparation and cleaning and reducing pollution from its direct combustion.

***Direct Energy Conversion (DEC)*–PB86-946600.** Photovoltaics, magnetohydrodynamics, electrohydrodynamics, thermoelectrics, thermionics, and fuel cells.

***Energy from Biomass (EFB)*–PB86-900600.** Biomass production, conversion, and utilization for energy.

***Geothermal Energy Technology (GET)*–PB86-914700.** Exploration, development, and utilization of geothermal resources.

***Heavy-Ion Reactions (HIR)*–PB86-900500.** Heavy-ion (A > 4) reactions.

***Laser Research (LAR)*–PB86-901100.** Laser research and development, excluding applications.

***Nuclear Fuel Cycle (NFC)*–PB86-913400.** Both front and back ends of the nuclear fuel cycle.

***Nuclear Reactor Safety (NRS)*–PB86-913500.** Accident analysis, safety systems, radiation protection, decommissioning and dismantling, and security measures.

***Radioactive Waste Management (RWM)*–PB86-902900.** Management aspects of transport and storage, waste processing, waste disposal, waste storage, radioactive effluents, and shipping containers.

***Solar Thermal Energy Technology (STT)*–PB86-901200.** Research and development of efficient and reliable solar thermal conversion systems.

***Transportation Energy Research (TER)*–PB86-900900.** Energy-efficient advanced automotive propulsion systems and transportation energy conservation.

***Unconventional Petroleum (UCP)*–PB86-901300.** Secondary and tertiary recovery of petroleum and oil shales and tar sands.

INTERNATIONAL ENERGY PUBLICATIONS

The Office of Scientific and Technical Information (OSTI) cooperates in the publication of international abstract journals with the following: (1) International Atomic Energy Agency, International Nuclear Information System, Vienna, Austria, for *Atomindex;* (2) International Energy Agency, Biomass Conversion Technical Information Service, Dublin, Ireland, for *Biomass Abstracts;* and (3) International Energy Agency, IEA Coal Research, London, England, for *Coal Abstracts.* In each case, the cognizant foreign agency provides the non-U. S. information to OSTI for inclusion in the Energy Data Base; in turn, OSTI provides the U. S. information for input into the respective journal.

Atomindex

A semimonthly abstract journal providing worldwide coverage of information on nuclear science and technology. *Atomindex* is available by subscription from UNIPUB, 345 Park Avenue South, New York, NY 10010. The cost of an annual subscription, 24 semimonthly issues and semiannual and annual cumulative indexes, is $290.

Biomass Abstracts

A bimonthly abstract journal with comprehensive coverage of information on the conversion of biomass to energy. *Biomass Abstracts* is available free to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Biomass Abstracts* from Biomass Conversion Technical Information Service, Institute for Industrial Research and Standards, Ballymun Road, Dublin 9, Ireland, for 42 IR pounds per year. Make checks payable to the Institute.

Coal Abstracts

A monthly abstract journal providing comprehensive worldwide coverage of information in the field of coal science and technology. *Coal Abstracts* is available to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Coal Abstracts* from IEA Coal Research, Technical Information Service, 14-15 Lower Grosvenor Place, London SW1W 0EX, England, for 100 pounds sterling per year.

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ENERGY RESEARCH ABSTRACTS

ABOUT THE OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION

The Office of Scientific and Technical Information (OSTI) in Oak Ridge, Tennessee, has been the national center for scientific and technical information for the Department of Energy (DOE) and its predecessor agencies since 1946. In developing and managing DOE's technical information program, OSTI places under bibliographic control not only DOE-originated information but also worldwide literature on scientific and technical advances in the energy field and announces the source and availability of this information. Whereas the literature of science is emphasized, coverage is extended to DOE programmatic, socioeconomic, environmental, legislative/regulatory, energy analysis, and policy-related areas. To accomplish this mission, OSTI builds and maintains computerized energy-information data bases and disseminates this information via computerized retrieval systems and announcement publications such as abstracting journals, bibliographies, and update journals. Direct access to OSTI's most comprehensive data base, the Energy Data Base, is available to the public through commercial on-line bibliographic retrieval systems. The Energy Data Base and many of OSTI's energy-related data bases are available to DOE offices and contractors and to other government agencies via DOE/RECON, the Department's on-line information retrieval system. The Office of Scientific and Technical Information has developed and maintains systems to record and communicate energy-related research-in-progress information, to maintain a register of DOE public communications publications, to track research report deliverables from DOE contractors, and to test and make available DOE-funded computer software programs with scientific and management applications; OSTI also serves as adviser for special publication needs of the Department. To effectively manage DOE's technical information resources, OSTI's program is one of continual development and evaluation of new information products, systems, and technologies.

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ABOUT *ENERGY RESEARCH ABSTRACTS*

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U. S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. The user should remain aware that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.

ERA is comprehensive in its subject scope, encompassing the DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

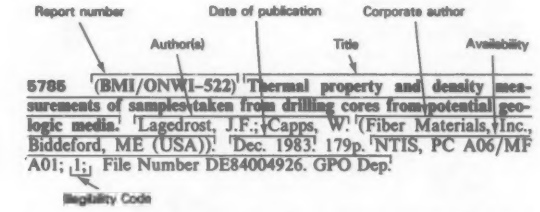
ERA is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Inquiries should be directed to the Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831.

ERA is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The subscription rate for the 24 semimonthly issues is $146.00 for domestic subscribers and $182.50 for foreign subscribers. A single issue costs $14.00 (domestic) or $17.50 (foreign). The cumulative indexes will be available in printed form from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The GPO Stock Number is 061-000-00675-3 and the price is $124.00 for the Vol. 10 indexes. The cumulative indexes are also available in microfiche form from the National Technical Information Service, U. S. Department of Commerce, Springfield, VA 22161, and from Engineered Systems, P. O. Box 866, Oak Ridge, TN 37831.

HOW TO USE *ENERGY RESEARCH ABSTRACTS*

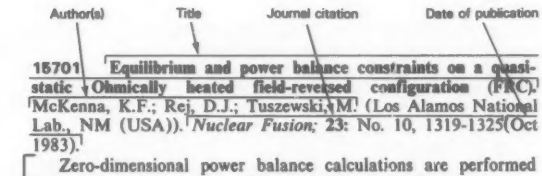
ABSTRACTS IN *ENERGY RESEARCH ABSTRACTS*

The principal elements of abstract entries for a typical research and development report and a typical technical journal article are illustrated below.



5785 (BMI/ONWI-522) **Thermal property and density measurements of samples taken from drilling cores from potential geologic media.** Lagedrost, J.F.; Capps, W. (Fiber Materials, Inc., Biddeford, ME (USA)). Dec. 1983. 179p. NTIS, PC A06/MF A01; 1; File Number DE84004926. GPO Dep.

Abstract: Density, steady-state conductivity, enthalpy, specific heat, heat capacity, thermal diffusivity and linear thermal expansion were measured on 59 materials from core drill samples of several geologic media, including rock salt, basalt, and other associated rocks from 7 potential sites for nuclear waste isolation. The measurements were conducted from or near to room temperature up to 500°C, or to lower temperatures if limited by specimen cracking or fracturing. Ample documentation establishes the reliability of the property measurement methods and the accuracy of the results.



15701 **Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC).** McKenna, K.F.; Rej, D.J.; Tuszewski, M. (Los Alamos National Lab., NM (USA)). *Nuclear Fusion;* **23**: No. 10, 1319-1325 (Oct 1983).

Abstract: Zero-dimensional power balance calculations are performed for a quasi-static, purely Ohmically heated field-reversed configuration. Without compression, the constraint imposed by radial pressure balance limits the power input. Estimates of the energy loss from impurity line radiation as well as from classical and anomalous transport are given. Effects of cold puff gas injection are also investigated.

INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA).* Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

● Corporate Author Index

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

5785 (BMI/ONWI-522) **Thermal property and density measurements of samples taken from drilling cores from potential geologic media.** Lagedrost, J.F.; Capps, W. **(Fiber Materials, Inc., Biddeford, ME (USA)).** Dec. 1983. 179p. NTIS File Number DE84004926. GPO Dep.

is indexed as:

Fiber Materials, Inc., Biddeford, ME (USA)

● Personal Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Capps, W., *See* Lagedrost, J. F.
Lagedrost, J.F., Thermal property and density measurements of samples taken from drilling cores from potential geologic media, 9:5785 (R;US)
McKenna, K.F., Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC), 9:15701 (J;US)
Rej, D.J., *See* McKenna, K.F.
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● Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

SALT DEPOSITS
Density
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REVERSED-FIELD PINCH
Energy Balance
Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC), 9:15701 (J;AT)

● Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

AC06-76RL01830	**Fiber Materials, Inc., Biddeford, ME (USA)**	
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● Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. Patents and conference papers are indexed here as a matter of convenience. When a report is supplied under a File Number, that number is included in the availability statement. A file number–report number correlation is included for convenience.

BMI/ONWI-		
522	9:5785	NTIS, PC A09/MF A01. File Number DE84004926, Distribution Category MN-70

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Much of the information is provided by (1) bilateral exchange agreements with foreign organizations, and (2) exchange agreements or contracts with other U. S. government agencies, private firms, or institutions.

Foreign Sources

CEA Centre d'Etudes de Saclay
GIF-sur Yvette Cedex, France

Fachinformationszentrum
Energie, Physik, Mathematik GmbH
Karlsruhe, Federal Republic of Germany

IEA Biomass Conversion Service
Dublin, Ireland

IEA Coal Research
Technical Information Service
London, England

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New York, NY

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Oak Ridge, TN

National Aeronautics and Space Administration
Scientific and Technical Information Division
Springfield, VA

National Institutes of Health
National Library of Medicine
Bethesda, MD

NOVA Information Services Company
Commack, NY

Plenum Publishing Corporation
New York, NY

University of Tennessee
Graduate School of Library and Information Sciences
Knoxville, TN

Communication concerning the editorial policy and content of *Energy Research Abstracts* should be addressed to the Editor, *Energy Research Abstracts,* Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831.

SUBJECT CONTENTS (NUMERICAL LISTING)

Six-digit subject category numbers are used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's computerized bibliographic information system. The six-digit category numbers are utilized as if they were three pairs of two-digit numbers, the first two pairs being used to arrange the abstract content of *Energy Research Abstracts*. The following listing includes the totality of the 39 first-level and 286 second-level subject categories used. Because each issue of *ERA* announces only those documents becoming available during a semimonthly period, some subject categories may not be represented in every issue. The complete subject category scheme with scope definitions and limitations is available as DOE/TIC-4584-R6 from NTIS for $9.50.

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ENERGY RESEARCH ABSTRACTS

01 COAL AND COAL PRODUCTS

37258 (CONF-8509275—, pp 293-298) **Swedish peat research foundation (SST) - machinery and methods.** Olsson, R.; Ranta, P.; Anttila, R. (Swedish Peat Research Foundation, Umeaa, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

SST was established in 1983 when eleven peat companies, national and local authorities decided to start up a peat research organization. The initial work has also been possible due to a grant from the Norrland Foundation in Luleaa. The foundation is open to joining for peat companies, local and national authorities in the Scandinavian countries including Finland. SST is today owned by about 30 members consisting of peat producing and peat using companies as well as peat machine- and peat combustion equipment manufacturers as well as research institutions, national and local authorities. The purpose of the reserch foundation is to organize and carry on peat research in a collective form. Research areas include all aspects of peat production and utilization from characterization of peat deposits to developement of peat production techniques, the use of peat both as a fuel, as horticultural peat and as a raw material for industrial use. This paper describes the structural constitution of SST's whole research area, completed and started projects, and research programme 1985-1988. (author).

37259 (DOE/FE/60181—2063) **Low-rank coal research: a select bibliography of federal publications for 1980-1984.** Boley, C.C.; Scott, M.W.; Giese, T.L. (North Dakota Univ., Grand Forks (USA). Energy Research Center). Jun 1986. Contract FC21-83FE60181. 53p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86006622.

This bibliography is a listing of all technical publications and reports that have been prepared or sponsored by the University of North Dakota Energy Research Center (UNDERC), its predecessor, the Grand Forks Energy Technology Center (GFETC), or the Department of Energy Grand Forks Project Office (GFPO), and issued from 1980 through 1984. This listing updates Low-Rank Coal Publications Contributed by Grand Forks Energy Technology Center, United States Department of Energy, 1939-1979, compiled by Charles C. Boley in 1980.

37260 (DOE/METC—86/0227) **Low-rank coal program. Technology status report.** (USDOE Morgantown Energy Technology Center, WV). Dec 1985. 71p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86001027.

The Department of Energy (DOE), through the Grand Forks Project Office (GFPO), is conducting basic research on peat, subbituminous and lignite coal and coal product properties, bench-scale and process development unit-scale (PDU) studies of existing and advanced concepts of use and conversion process, and environmental studies that are related directly to the use of LRC's. This activity emphasizes research that recognizes the distinctive properties and technological applications that detract from and/or enhance the efficient and environmentally sound use of LRC. Research that recognizes these applications will help to ensure that the development of LRC's contributes to the goal of the National Energy Policy Plan (NEPP), which is to provide an adequate supply of energy at reasonable costs. The ability of existing and emerging technologies to utilize these fuels will enhance the applicability of LRC's for energy production. The full use of LRC's depends upon the understanding and resolution of numerous potential problem areas that are related to the characteristics of LRC, and to the specific technological applications that may use these coals. The potential problem areas and potential technological applications encompass a broad range of research and development needs.

37261 (STEV-TORV—86-10) **Russian handbook of peat. Translation of selected parts of the edition of 1984.** Lundgren, G. (Statens Energiverk, Stockholm (Sweden)). Jun 1985. 162p. (In Swedish). NTIS (US Sales Only), PC A08/MF A01. File Number DE86752279.

The following chapters have been translated into Swedish: Chapter 2: Physical and mechanical properties and the mechanics of peat layers. Chapter 3: Technical analysis of peat. Chapter 7: Field drying of peat. Basic meterological factors for peat extraction areas. Chapter 17: Mechanical treatment of peat. Production of briquettes and thermally insulating plates. Chapter 18: Thermochemical and biochemical treatment of peat. (G.B.).

0104 Processing

REFER ALSO TO CITATION(S) 37287, 37296, 37306, 37306, 37313, 37336, 37385, 37386, 37491, 37491, 37505, 37781, 38491

37262 (CONF-8509275—, pp 221-225) **Technical development in order to obtain satisfactory combustion.** Asplund, F. (Scandiaconsult AB, Stockholm, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

A combustion system with a gasifier of co-current design have been developed, and is now being introduced on the market. The prototype with a nominal heat output of 3 MW has been tested for a short period. The main fuel has been peat with a moisture content (wet base) ranging from 30% to 60%. Wood chips and coal also have been fired. The reactor has been connected to a standard boiler designed for oil-firing. The second stage has been designed for producing a blue flame, and no soot formation has been detected during the tests. After two weeks of testing, including several start-ups, there has been no indication of reduced boiler capacity, even in view of the fact that no cleaning has been performed.

37263 (DOE/BC/10824—2) **Assessment of research and development in support of the PCT properties program for synthetic fuels technologies. Final report.** Freeman, R.D.; Dermer, O.C. (Oklahoma State Univ., Stillwater (USA). Dept. of Chemistry). [1986]. Contract AC03-84BC10824. 72p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86007849.

A review of six previous relevant reports indicates a clear consensus that considerable additional PCT data are needed for the components of coal liquids if the design of future coal-conversion plants is to be even approximately optimal. For many components, data are needed for the entire temperature-pressure region: 0 to 500°C and 0 to 150 bar; for many others, additional data are required for the important upper half or third of this temperature-pressure region. Detailed results from a survey of laboratories working on PCT properties are presented. It is clear that the PCT data required for optimal plant design almost certainly will not be available in the foreseeable future unless a major effort is funded, e.g., by DOE. Specific compounds, which are components of coal liquids or reasonable model compounds, are recommended for immediate study of PCT properties. The rationale for the choice is discussed in some detail; a mechanism is suggested for continually modifying and updating the list of important compounds and the types of data needed for them. 108 refs.

37264 **(DOE/FE—0011) Analysis of the market and product costs for coal-derived high Btu gas.** (Department of Energy, Washington, DC (USA)). Dec 1980. 27p. NTIS$6.50.

DOE analyzed the market potential and economics of coal-derived high-Btu gas using supply and demand projections that reflect the effects of natural gas deregulation, recent large oil-price rises, and new or pending legislation designed to reduce oil imports. The results indicate that an increasingly large market for supplemental gas should open up by 1990 and that SNG from advanced technology will probably be as cheap as gas imports over a wide range of assumptions. Although several studies suggest that a considerable market for intermediate-Btu gas will also exist, the potential supplemental gas demand is large enough to support both intermediate - and high-Btu gas from coal. Advanced SNG-production technology will be particularly important for processing the US's abundant, moderately to highly caking Eastern coals, which current technology cannot handle economically.

37265 **(DOE/FE/60181—215) Pyrolysis and devolitalization.** Ross, S.F. (North Dakota Univ., Grand Forks (USA). Energy Research Center). 1986. Contract FC21-83FE60181. 8p. (CONF-860649—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010899.

From 6. annual gasification contractors' meeting; Morgantown, WV, USA (24 Jun 1986).

The pressurized small pyrolysis reactor system (PSPR) shown in Figure 1 was designed to allow for the pyrolysis of coal under a variety of experimental conditions and the subsequent trapping of water-soluble organic compounds produced. The experimental conditions which can be varied include the type of gas atmosphere, pressure, gas flow rate heating rate, and final temperature. The system is pressurized using an ordinary gas cylinder containing the desired gas mixture. The gases used to date include pure nitrogen and a 2:1 volume ratio of carbon monoxide and hydrogen. The entire system is constructed of 304 stainless steel, 316 stainless steel and Hastelloy X and can accommodate a variety of corrosive gas mixtures. The pressure is controlled using a two-state regulator with a maximum delivery pressure of 500 psig. The gas passes through a high-pressure oxygen trap which removes oxygen to a residual level of less than 0.1 ppM. A mass flow controller is used to regulate the flow rate of gas through the furnace tube. The range of available flow rates is 0 to 100 cc/min at 400 psig outlet pressure or 0 to 2821 standard cc/min (approximately 3 liters/min at atmospheric pressure). A needle valve is used to bypass the mass flow controller, allowing the system to be brought from atmospheric pressure to 400 psig in a matter of seconds. The gases produced pass through a liquid nitrogen-cooled stainless steel trap partially filled with 3 to 4 mm glass beads to trap the water-soluble organic effluents. The trap can be removed from the system in seconds using a quick disconnect Cajon VCR coupling. The heating rate is adjustable from 0 to 23°C/min and the maximum furnace temperature is 1100°C (2010°F). Time/temperature profiles are displayed and stored on an IBM PC/XT which is interfaced to the reactor system by a two channel analog/RS-232C interface. 2 refs., 2 figs., 2 tabs.

37266 **(DOE/MC/20230—T3) CNG Acid gas removal process. Technical progress report 2, 1 December 1983-29 February 1984.** Auyang, L.; Liu, Y.C. (Helipump Corp., Cleveland, OH (USA)). 1985. Contract AC21-83MC20230. 38p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE85018325.

Development work on the CNG acid gas removal process under DOE Contract No. AC21-83MC20230 continued during the period December 1, 1983 through February 29, 1984. Two tasks were active during this time: Task 1 hydrogen sulfide absorber (design and construction of hydrogen sulfide absorber); and Task 4 technology transfer. Within Subtask 1.1, the flow sheet of the integrated hydrogen sulfide absorber and the carbon dioxide triple-point crystallizer is reviewed. Control objectives of the hydrogen sulfide absorber and control strategies were established and are discussed. Within Subtask 1.2, detailed engineering designs have been completed for the absorption column, the light ends flasher, cooler/condenser, and the liquid carbon dioxide surge tank. This equipment is now in various stages of construction. Other process equipment specified and placed on order includes the main gas compressor, recycle light ends gas compressor, liquid carbon dioxide absorbent pump, and the concentrated acid gas stream pump. Within Task 4, two papers discussing the CNG acid gas removal technology have been prepared. One paper will be presented in the Acid and Sour Gas Symposium at the AIChE Winter National Meeting, Atlanta, Georgia. The other paper will be presented at the Eleventh Energy Technology Conference, Washington, DC. 10 figs., 5 tabs.

37267 **(DOE/PC/70753—T7) Study of some transition metal complexes as process catalysts. Quarterly report, March 1-May 31, 1986.** Wilson, B.L. (Texas Southern Univ., Houston (USA). Dept. of Chemistry). 1986. Contract FG22-84PC70753. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012099.

Direct coal liquefaction of Illinois Number Six River King coal was conducted in a half-liter stirred autoclave. When 16,000 ppM by weight of molybdenum based on dry/ashless coal are added to coal in the form of ammonium molybdate both cyclohexane and THF conversions are substantially increased. Cyclohexane conversion increased from 34.7% for the noncatalyzed case to 54.4% for the ammonium molybdate catalyzed case and the THF conversion increased from 87.4% to 92.4%, respectively, for the noncatalyzed and catalyzed cases. When 2000 ppM by weight of cobalt based on dry/ashless coal in the form of $CoSO_4 \cdot 7H_2O$ were used as the catalyst there was very little change in the cyclohexane conversion from 34.7% for the noncatalyzed case to only 37.9% for the catalyzed case and the change in the THF conversion from 87.4% to 88.2% for the noncatalyzed and catalyzed cases, respectively, could not be considered a significant change at all. However, when $Co(H_2B(Pz)_2)_2$ was used in a manner and portion similar to the $CoSO_4 \cdot 7H_2O$ the conversions were 47.4 and 92.4 for cyclohexane and THF respectively. 5 tabs.

37268 **(DOE/PC/70812—7) Improved catalysts for coal liquefaction. Quarterly report No. 7, March 1-May 31, 1986.** Haynes, H.W. Jr.; McCormick, R.L. (Wyoming Univ., Laramie (USA). Dept. of Chemical Engineering). 24 Jun 1986. Contract FG22-84PC70812. 38p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012288.

During the last quarter a simple batch reactor test was developed for screening catalysts in terms of their initial activities. The results of replicant tests indicate that the variability in the experiment is sufficiently low that real distinctions can be made among the various catalysts. Only those preparations which appear promising in the batch experiment will be subjected to further testing. Five runs were completed in the continuous unit. These included a brief process variable study on a new feedstock designated FSN-30, a thermal (noncatalytic) run, and deactivation runs on three catalysts. The most extensive deactivation run was a 500+ hour run on a commercial cobalt molybdate catalyst, AMOCAT 1A. The purpose of this run was to provide a basis for comparison with catalysts prepared in the laboratory. AMOCAT 1A has seen service in HRI's CTSL pilot plant and more recently as a first stage catalyst at Wilsonville. It is believed to be superior to nickel molybdate catalysts for service at high temperatures. A chromia-alumina catalyst performed very poorly in both the batch and continuous units, but a CoMo/chromia-alumina catalyst exhibited specific activities roughly comparable to the commercial catalyst. The deactivation curve for the chromia-alumina based catalyst appeared similar to that of the commercial catalyst for the duration of the 200 hour experiment. 11 refs., 5 figs., 14 tabs.

37269 **(DOE/PC/70814—6) Direct coal liquefaction using iron-titanium hydride as a hydrogen distribution and catalytic material. Final report.** Smith, J.E. Jr. (Alabama Univ., University (USA). Dept. of Chemical Engineering). 30 May 1985. Contract FG22-84PC70814. 73p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86011868.

This one and a half year project investigated the feasibility of a new approach to direct coal liquefaction. The process used iron-titanium hydride to transport and distribute hydrogen to a coal slurry while catalyzing the liquefaction reaction. Significant developments have been made in overcoming problems encountered in

other liquefaction processes. This approach eliminates sparging of gaseous hydrogen during liquefaction, reduces catalytic deactivation found in supported catalyst approaches, while converting coal to liquid products at reduced operating conditions. During this study, thirteen batch liquefaction experiments and a hydrogen adsorption study of the spent alloy were performed to address catalytic activity and product selectivity for this system. Conversion as high as 60% with Utah coal and 55% with an Alabama agglomerating coal were recorded in less than 30 minutes at an average temperature of 500°F and preasures in the range of 500 to 600 psia. Comparison with coal slurried in kerosene, suggested that tetralin was involved as a shuttling agent. The alloy only showed a 4% deactivation, based on hydrogen readsorption, and no visible signs of coking were observed. The catalyst was easily recovered from the slurry, and after a room temperature wash in THF was ready for recycle. This catalytic process was found to reduce nitrogen, sulfur, and oxygen content of the resulting liquid product by 25%, 50%, and 89.5%, respectively. 66 refs., 19 figs., 17 tabs.

37270 (DOE/PC/80907—T2) Reactivity of coal in direct hydrogenation process. Technical progress report, March-May 1986. Baldwin, R.M.; Miller, R.L. (Colorado School of Mines, Golden (USA). Dept. of Chemical Engineering and Petroleum Refining). 1986. Contract FG22-85PC80907. 38p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012069.

This report summarizes the research carried out during the past three months on DOE grant No. DE-FG22-85PC80907, entitled "Reactivity of Coal in Direct Hydrogenation Processes." The overall objective of the research program is to measure and model the rate and extent of coal liquefaction under some standard set of reaction conditions for a wide suite of coals, and then to correlate the observed liquefaction reactivity with basic coal chemical and geochemical features. Over the last quarter, all experimental work (consisting of 175 experimental runs) on the first coal suite was completed. This suite was comprised of a set of 13 coals from the Exxon sample bank. The rate and extent of conversion of each coal to THF-solubles, asphaltenes, preasphaltenes, oils and gas were measured from microautoclave (tubing-bomb) runs in an inert vehicle (1-methylnaphthalene) at 425°C. The data clearly show striking differences in both the rate and extent of reaction, not only for total conversion (to THF-solubles) but in the liquefaction fractions (asphaltenes, preasphaltenes, etc.) as well. The raw data has been reduced via kinetic modeling, and a single unified model capable of adequately describing the rate of conversion to THF-, toluene-, and pentane- solubles has been developed. Statistical testing for all coals in the suite has shown a second-order pseudo-irreversible rate expression to be an adequate descriptive model for the true coals in the data set. Data were corrected prior to kinetic analysis to account for the small non-isothermal period present in the reaction. 5 refs., 17 figs., 6 tabs.

37271 (DOE/PC/80913—3) Biodegradation and bioconversion of coals by fungi. Quarterly progress report No. 3, April 1-June 30, 1986. Ward, B. (Mississippi Univ., University (USA). Dept. of Biology). 1986. Contract FG22-85PC80913. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012939.

We continued to screen lignite-derived fungal isolates for lignite bioconversion activity as described in the previous quarterly reports. We now have about 24 new and different strains, representing diverse taxa, which exhibit some degree of lignite biosolubilization. Each new active strain derived from weathered lignites has been tested on three different lignites under our standardized assay conditions. Data on extent and rate of solubilization activity were collected for each fungal isolate challenged with each of the three lignites. We began testing new fungal isolates derived from weathered bituminous coals collected from sites in Alabama. These isolates, along with several of the lignite-solubilizing strains, are being tested for biosolubilization of bituminous coals. The bituminous-derived isolates also are being tested for lignite solubilization. Taxonomic studies on all isolates are underway and we have made tentative identifications of several of the lignite-active strains. 1 fig., 2 tabs.

37272 (LA-UR—86-2127) Utilization of the S-cubed, entrained-flow coal gasification model (EFCG). Hill, S.C. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 9p. (CONF-860649—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012404.

From 6. annual gasification contractors' meeting; Morgantown, WV, USA (24 Jun 1986).

The objectives are: to evaluate and apply the DOE/EPRI-supported entrained-flow coal gasification code (EFCG) and to assess the accuracy and utility of the code. This will include examining the individual submodels for applicability, accuracy, and stability; comparing model predictions with analytical solutions and laboratory measurements; applying the code to industrial gasification systems; and documenting it to enhance code utility for a diverse group of potential users. Several code modifications were made in FY 1986. The major modification was the addition of a global radiative heat transfer model to the EFCG. Another modification was the extension of the graphics package developed previously to treat reacting flows. Most of the effort during FY 1986 has focused on developing a user's manual for the EFCG. This manual is near completion, and will be delivered to METC at the end of FY 1986. 2 refs., 4 figs.

37273 (LBL—21340) Chemistry and morphology of coal liquefaction. Quarterly report, January 1, 1986-March 31, 1986. Heinemann, H.; Fish, R.H. (Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012682.

Having recently discovered that polynuclear heteroaromatic nitrogen compounds can be selectively reduced only at the nitrogen containing ring, we have now turned our attention towards the cleavage of the carbon nitrogen bonds in this reduced ring. Highlights for this reporting period are: (1) Studies with the 50% nickel oxide catalyst clearly show that 1,2,3,4-tetrahydroquinoline(THQ) provides approximately 20% more liquid product that does quinoline. Thus a first step selective hydrogenation to 1,2,3,4-THQ would enhance the overall HDN reaction to provide a more substantial conversion to substituted benzene and aniline derivatives. (2) The dramatic effect of the nitrogen atom is to inhibit aromatic ring hydrogenation and, to some extent, carbon-carbon bond hydrogenolysis reactivity. This is shown with proplybenzene as the substrate, where only methane gas is produced in the HDN reaction with the 50% nickel oxide catalyst. (3) The HDN reaction of cyclohexylamine only provides benzene and methane, with no apparent formation of cyclohexane. Thus dehydrogenation is an important side reaction.

37274 (PB—86-192366/XAB) Fluidised-bed gasification rig - final report. Bonapace, A.C. (National Inst. for Coal Research, Pretoria (South Africa)). 5 Mar 1983. 62p. (COAL—8406). NTIS, PC A06/MF A01.

The construction and development of a test rig for the fluidized bed gasification of coal is described. Tests were carried out on coals of qualities varying from discards to marketable coal. The results showed good outputs from the particular size of rig (200 mm diameter), but gas quality was somewhat variable.

37275 (PB—86-195278/XAB) Coal-gasification environmental data summary: trace elements. Final report, September 1984-December 1985. Holcombe, L.J.; Achord, R.D.; Magee, R.A.; Mann, R.M. (Radian Corp., Austin, TX (USA)). Apr 1986. 120p. NTIS, PC A06/MF A01.

The report summarizes trace-element measurements made at several coal-gasification facilities. Most of the measurements were made as part of EPA's source testing and evaluation program on low- and medium-Btu gasification. The behavior of trace elements is discussed in light of their distribution from feed coal to various discharge, product, and by-product streams. The summary provides a basis for decisions concerning monitoring needs at coal gasification facilities. The stream-flow data and trace-element-concentration measurements were typically not precise or accurate enough to make quantitative conclusions concerning trace-element behavior in the gasifiers. However, some general trends in element distribution are apparent. Elements that consistently had more than 70% of

their total inlet mass partition to the bottom ash or slag included Al, Ba, Co, K, U, W, and Zr. Other elements had consistently less than 70% of their mass partition to the bottom ash, and had significant mass flow in the overhead gas and aerosols.

37276 **(PNL-SA—13970) Potential benefits of improved mass transfer in SSMS hot gas cleanup.** Lyke, S.E.; Butner, R.S.; Roberts, G.L. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 15p. (CONF-860648—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012152.

From 6. annual contractors' meeting on contaminant control in coal-derived gas streams; Morgantown, WV, USA (4 Jun 1986).

The overall objective of this project is to evaluate the potential for cost-effective hot gas cleanup with solid supported molten salt (SSMS). Optimization of sorbent capacity and mass transfer rate are being studied through modeling and experimentation. The computer model and experimental data developed should allow accurate engineering evaluation of current technology and of potential improvements if performance could be increased to practical limits. Work to date was focused on modeling, equipment preparation and sorbent fabrication. Preliminary modeling results and sorbent preparation progress are described. 6 refs., 10 figs.

37277 **(SAND—86-0749C) Char consumption in the underground gasification of Eastern bituminous coal.** Skocypec, R.D.; Cook, D.W.; Engler, B.P. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 15p. (CONF-860822—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012162.

From 12. annual symposium on underground coal gasification; Saarbrucken, F.R. Germany (25 Aug 1986).

A series of small-scale laboratory gasification experiments has been conducted to better understand the gasification process of Eastern bituminous coal constrained in an axisymmetric borehole geometry. It is clear that conditions and char consumption rates necessary for self-sustained gasification of bituminous coal cannot be obtained with oxygen-enriched air injection. Steam/oxygen injection produced better but inconclusive results. To understand why conditions that were adequate to ignite solid carbon (1200°C temperatures, 50% oxygen) only devolatized and did not combust and gasify the coal, extensive postburn surface, material and structural analyses were conducted. As a result, we have identified a process we believe to be of critical importance to gasification of bituminous coal constrained in a borehole geometry - the deposition of pyrolytic carbon. In the experiments, pyrolytic carbon deposited along the borehole surface and in the char pore structure from the hydrocarbon vapor outgas: it did not form in an experiment using subbituminous coal. Pyrolytic carbon is impervious to gas penetration, is very resistant to oxidation and strengthens the char substrate; it forms a barrier to the diffusion of oxygen and feed gas to carbon in the char. In essence, it seals the char from reacting with the borehole gas mixture and it decreases the propensity of the char to spall and expose fresh char. Steam/oxygen injection, producing gaseous hydrogen in the borehole, successfully inhibited pyrolytic carbon deposition on the borehole surface, but did not inhibit pyrolytic carbon deposition in radial fissures and within the char matrix pore structure. Since gasification requires the reaction of solid carbon in the char, the formation of pyrolytic carbon is detrimental, at best, to the gasification process. 14 refs., 13 figs.

37278 **Biomedical implications of altered product composition in advanced coal liquefaction processes.** Wilson, B.W.; Mahlum, D.D.; Pelroy, R.A. (Pacific Northwest Lab., Richland, WA, USA). *Fuel Processing Technology;* **13**: No. 1, 1-16(Apr 1986). Contract AC06-76RL01830.

Chemical and toxicologic characteristics of direct coal liquefaction materials are highly dependent upon the specific process operations by which the coal liquids were produced, including, in particular, those that affect boiling point range and degree of hydrogen incorporation. Recent advances in direct coal liquefaction technology, such as the use of catalytic hydrogenation, reduced liquefaction severity and lowering the upper temperature cut point for the distillation of fuels, have resulted in products with higher hydrogen-to-carbon ratios and lower heteroatom content. These higher-quality fuels tend to be less mutagenic and carcinogenic in laboratory assays than earlier coal liquefaction products. It is likely that application of postproduction hydrotreatment, as well as restriction of upper distillation temperature, for coal-based fuel products could result in materials that exhibit mutagenic or carcinogenic activity which is no greater than that of their petroleum-derived counterparts. 2 figs., 3 tabs., 46 refs.

37279 **Hydroprocessing of nondeashed coal-derived residuum: evaluation of catalyst performance.** Cillo, D.L.; Stiegel, G.J.; Tischer, R.E.; Narain, N.K. (Pittsburgh Energy Technology Center, PA, USA). *Fuel Processing Technology;* **13**: No. 1, 65-76(Apr 1986).

Four commercially available catalysts were evaluated for 100 hours in a continuous-flow unit to determine their effectiveness in the hydrotreating of nondeashed coal-derived residuum. These included Shell 324M and Shell 424 (both unimodal), and Shell 317 and Amocat 1C (both bimodal). All catalysts contained nickel and molybdenum supported on alumina; compositions were, however, different. The results showed that all catalysts performed equally well, except that the desulfurization activity of Shell 424 was substantially higher than the activities of the other catalysts. The bimodal catalysts accumulated more carbonaceous material and trace metals than the unimodal catalysts. Also, their catalytic activity was similar to the activities of the unimodal catalysts. 3 figs., 5 tabs., 16 refs.

37280 **Characterization and pyrolysis of separated coal macerals.** Winans, R.E.; Scott, R.G.; Neill, P.H.; Dyrkacz, G.R.; Hayatsu, R. (Argonne National Lab., IL, USA). *Fuel Processing Technology;* **12**: 77-88(Mar 1986). (CONF-8506112—). Contract W-31-109-ENG-38.

From US/France joint seminar on coal chemistry; Marseille, France (1 Jun 1985).

Precise mass measurement Pyrolysis Mass Spectrometry (PyMS) is used to characterize separated coal macerals and to examine and contrast their reactivity under vacuum pyrolysis and short contact time (SCT) liquefaction conditions. Even over a limited rank range variation with rank can be observed. Different liptinites yield very different PyMS results which help explain variations in SCT yields. Oxygen and sulfur organic compounds appear to influence reactivity. 3 tabs., 7 figs., 22 refs.

37281 **Catalysis of coal conversion at mild temperatures.** Anderson, L.L.; Miin, T.C. (Utah Univ., Salt Lake City, USA). *Fuel Processing Technology;* **12**: 165-174(Mar 1986). (CONF-8506112—).

From US/France joint seminar on coal chemistry; Marseille, France (1 Jun 1985).

Many materials have been used or tested as catalysts for the direct conversion of coal to liquids. However, the factors which determine whether a particular substance will be an excellent, fair or poor catalyst, or an inhibitor, are still not understood. Most of the catalyst studies have been of empirical nature and neither the specific catalytic mechanisms not the exact forms responsible for the catalytic effects observed have been elucidated. In studies on the catalytic action of Lewis acids for the liquefaction of coal, many properties of these materials were correlated. After testing more than eighty catalysts, only one property was found to directly correlate with the yield of liquefaction products in coal conversion experiments. This property was found to be the electronic softness of the Lewis acids studied. Results from mild liquefaction experiments on bituminous coal have been obtained and give insight into the reactions taking place and the moieties involved in most of the liquefaction reactions. 7 tabs., 26 refs.

37282 **Coal conversion and hydrogen utilization in catalytic liquefaction at low temperatures.** Bockrath, B.C.; Finseth, D.H.; Illig, E.G. (Pittsburgh Energy Technology Center, PA, USA). *Fuel Processing Technology;* **12**: 175-188(Mar 1986). (CONF-8506112—).

From US/France joint seminar on coal chemistry; Marseille, France (1 Jun 1985).

The initial stages of coal liquefaction have been investigated in small batch autoclaves at moderate to low liquefaction temperatures. Conventional liquefaction in an organic recycle solvent was compared with liquefaction of coal in water. In conventional liquefaction, the majority of the tetrahydrofuran conversion ultimately

obtained at long reaction times had already appeared before 15 minutes or less had elapsed at the set temperature. Addition of ammonium molybdate had a beneficial effect on conversion at lower temperatures as revealed by a decrease in the demands placed on the liquefaction solvent. The use of a catalyst under hydrogen pressure may compensate for the suppression of conversion values normally associated with using substantially smaller amounts of liquefaction solvent. The utilization of hydrogen was determined by elemental and NMR analyses of the organic portion of the entire charge fed to and taken from the autoclave. The net change in hydrogen per 100 carbons was calculated for four categories: hydrogen gas make, heteroatom removal, change in aromaticity (hydrogenation/dehydrogenation), and matrix bond cleavage/condensation. Hydrogen consumption is observed below 400°C in the hydrogenation of aromatic carbon. However, above 400°C, dehydrogenation reactions predominate and hydrogen is released in this category rather than consumed. These results show that the choice of liquefaction temperature, catalyst, solvent, and pressure of reducing gas may be used to control the pattern of hydrogen utilization. 5 figs., 5 tabs., 8 refs.

37283 **Acoustic velocity and attenuation measurements in thin rods with application to temperature profiling in coal gasification systems.** Gopalsami, N.; Raptis, A.C. (Argonne National Lab., IL). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Sonics and Ultrasonics;* SU-31: No. 1, 32-39(Jan 1984).

This paper is concerned with the application of ultrasonic thermometry for temperature profiling in the reactors of coal gasification plants. A temperature profiling sensor typically uses a thin rod with several notches to segregate the sensor length into various zones. An acoustic pulse transmitted through the multizone sensor is partially reflected back at each notch, and measurement of the time interval between each pair of the reflected signals provides an indication of the average temperature in the corresponding zone. The main contributions of this paper are (1) delineation of the reflection and transmission phenomenon of sound waves at a notch, (2) development of an improved method of attenuation measurement in single-zone and multizone sensors employing notches, and 3) determination of the acoustic properties, namely, velocity and attenuation of six candidate materials suitable to the gasifier environment in the temperature range from ambient to 1093°C. Computer simulation was employed to analyze the reflected signals from the notches, and the simulation results were corroborated at each stage by experiments. 19 references, 6 figures, 2 tables.

37284 **Modeling of self-gasification of coal.** Chang, H.L.; Himmelblau, D.M.; Edger, T.F. (The Dept. of Chemical Engineering, The Univ. of Texas at Austin, Austin, TX). pp 11 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

Self-gasification of coal is an important phenomenon in underground coal gasification (UCG). Self-gasification can occur at the walls of a UCG cavity and thus may have some influence on cavity growth. A model of self-gasification has been developed as a sub-model in a code to predict sweep efficiency in UCG. In this model the porous coal seam is divided into five zones (layers): ash, pyrolysis/gasification, drying, wet coal, and undisturbed coal. Four gas-char reactions, the water gas shift reaction, and four pyrolysis reactions are considered, using H_2O, CO, CO_2, H_2, and CH_4 as the principle gas constituents. Twelve ordinary differential equations must be solved during simulation; this is done using a stiff equation integrator developed at Lawrence Livermore Laboratory (LSODES). Of primary interest in the simulation runs is the effect of moisture influx on the consumption of coal. Comparison of the model predictions with laboratory and field data shows that self-gasification contributes most of the cavity growth in the reduction zone but is insufficient to predict growth rates in the oxidation zone (near the injection well).

0105 By-products

REFER ALSO TO CITATION(S) 37496, 37497

0106 Properties

REFER ALSO TO CITATION(S) 37263, 37340, 37347, 37352, 37355, 37372, 37388, 37390, 37746

37285 (CONF-8509275—, pp 25-28) **Physical properties of peat related to the peatland type.** Staffansson, H. (Swedish Peat Prospecting Co., Enviken, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

In two recent studies (4,5) several physical properties has been related to the peatland type. It has been found that the peat type is clearly correlated to the peatland type. In bogs 75% of the peat content is built up by sphagnum dominated peats (S-CS), while 70% of the peat content in fens is built up by sedge dominated peats (C-SC). In mixed mires the peat is dominated by sphagnum-sedge peats (SC-CS). Also the ash content is very clearly correlated to the peatland type. Bogs have a very narrow variation betwen 0.5 and 2%, mixed mires vary between 1.5 and 5% and fens vary between 3 and 7%. Bulk density has a very wide variation and it is related to the humification degree and peat type on one hand and on hydrological factors on the other. High humification degree correlates with high bulk density, and sedge peat has higher bulk density than sphagnum peat. The bulk density is lower as the wetness increases. One is able to estimate the bulk density by using von Post's humification scale and a wetness scale also with 10 degrees. The typical high bulk density site is a treed fen or mixed mire with dry conditions on the surface while the typical low bulk density site is the centre of an open bog with small ponds and mud-bottom. With 5 refs. (author).

37286 (CONF-8509275—, pp 43-49) **Uranium and trace elements in Swedish mires.** Fredriksson, D. (Geological Survey of Sweden, Uppsala, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

The knowledge of behaviour and occurrence of trace elements in Swedish mires is relatively good. The reason for this is that peat analysis has been used as a tool in the prospecting for metals and minerals. The mires acts as filters and concentrate metals from the ground water. Regional patterns for metals can be traced from peat analysis. These patterns can usually be explained from geological data or anthropogen pollution. But modern demands from the environmental authorities has created a need for a more precise knowledge, especially for the elements of which the mining industry has not been interested in, for example sulphur, radium, mercury, beryllium and cadmium. For this reasons recently we have put together analytical results from more than 100 mires aimed for fuelpeat production. These mires are situated all over the country. The values are from composite samples taken in the so called peat industrial volume, this means that the marginal parts and the bottom layers of the mires are excluded from the sampling. The subsamples represent 0.2-0.5 samples per ha. (author).

37287 (CONF-8509275—, pp 53-57) **Peat - coal - a comparison.** Carlsson, R. (National Energy Administration, Stockholm, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Sweden has large resources of peat, which will be utilized as a substitute for imported oil and coal. However, the peat contains the same types of impurities as coal, and the same emission limits have to be met when peat is burned as for steam coals. In 1984, the Swedish National Energy Administration was given the task of investigating how environmental requirements could best be met in connection with peat combustion. This paper reports the results of this investigation. With 1 ref. (author).

37288 (CONF-8509275—, pp 301-306) **Analysis of peat and its waste products.** Larsson, H.E.; Burman, J.O.; Ruuth, T. (Sveriges Geologiska AB, Luleaa, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

The analytical laboratory at the Swedish Geological Co. has, thanks to advanced multi-element techniques, unique possibilities to perform broad surveys of the chemical composition of peat materials and its waste products. Besides ash content and calorific value, a wide array of both main constituent elements and trace elements are analysed. The systems are well suited to the concentration ranges which are of interest in peat exploration. The laboratory has an X-ray fluorescence equipment for direct analysis of ashed materials and a plasma spectrometer (ICP) for the analysis of dissolved samples. In addition to these multi-element analysis techniques, Swedish Geological Co. has an ion separation system for the analysis of uranium and thorium in very low concentrations. Analysis performance data, sample pretreatment procedures and detection limits will be presented. These factors are considered in relation to normal concentration ranges in peat products.

37289 (CONF-8509275—, pp 307-316) **Characterization of peat, a multivariate approach.** Albano, C.; Johansson, E.; Persson, J.Aa.; Naeslund, Aa.; Roeckner, C. (National Swedish Lab. for Agricultural Chemistry, Umeaa, Sweden; Umeaa Univ. Sweden. Research Group for Chemometrics). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Near infrared spectroscopy (NIR) and thermogravimetry (TG) in combination with a statistical method, partial least squares in latent variables (PLS), has been proved to be useful for quantitative determination of chemical and physical properties in complex samples of peat. Samples representing the major peat types in Sweden were used and the sample properties determined were for example calorific value, carbon content, hydrolyzable substance (R-value) and water content. With 7 figures and 7 refs. (author).

37290 (CONF-8509275—, pp 395-400) **Some applications of the use of peat in environmental problems.** Nyroenen, T.; Selin, P. (Vapo Oy, Jyvaeskylae, Finland). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Slightly humified (Sphagnum) peat can be applied to the prevention of environmental problems of different types. Peat is a multi purpose natural product which does not cause a new waste problem after use. The application of peat in environmental protection is based on the mechanical, biological and chemical filtering capability. Thermally treated peat is an efficient oil absorbing material on the sea or lakes. It also can be used to remove oil from the stones and vegetation at the coast line. The filter bed made from peat can be used to bind sewage sludge in wastewater purification plants thus reducing the trasportation of sludge. Furthermore, the sludge can be composted with peat producing useful growing substrate. The use of peat in animal sheds as an absorbing agent for liquids and manure reduces the losses of nitrogen and phosphorus containing compounds. The same idea can be applied in the mink and fox farms to prevent environmental problems. Peat is a cheap, natural material and it will find more appliations in environmental protection in the near future. With 5 refs. (author).

37291 (DOE/ER/13244—T2) **Report on DOE coal contract.** Jacobs, I.S. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Center). 28 Feb 1986. Contract FG02-84ER13244. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011979.

At MIT, during the recent period, many coal samples were subjected to short exposures (equal to or less than 15 sec.) of 2.45 GHz microwave energy, in an air environment. The coal was subsequently ground to fine sizes and subjected to HgMS (High Gradient Magnetic Separation). Untreated coal from the same source; e.g., the Illinois No. 6 batch (as a control), was also ground and separated. Magnetization measurements were carried out at MIT on these samples. Also chemical measurements of sulfur at MIT, and iron at Lerch Bros., Hibbing, MN, were made. A selection of potentially interesting samples were reexamined at GE-CRD by Mossbauer spectroscopy and by chemical analyses for iron and ash. It was disappointing to note that the "control" samples showed about the same level of magnetization in the "mags" fractions as microwave-treated samples and also (as shown in Table I) equivalent concentrations of iron. This statement applies to the Illinois coal samples. We did not evaluate other coal types at GE. Mossbauer Spectra were obtained on most of the coal samples listed in Table I. They are identified with comments in Table II. There were two goals in this effort. One was to try to track the iron distribution; i.e., does the iron-bearing clay follow with the "magnetic pyrite"; i.e., the pyrite which reports in the Mossbauer trace with the magnetic fraction. The other goal was to search for detectable amounts of known magnetically strong phases; e.g., pyrrhotite, magnetite, etc., formed during the processing - microwave exposure (and possibly grinding).

37292 (IS-T—1204) **Application of automated image analysis to the study of mineral matter in raw and processed coals.** Straszheim, W.E. (Ames Lab., IA (USA)). Jun 1986. Contract W-7405-ENG-82. 372p. NTIS, PC A16/MF A01; 1; GPO Dep. File Number DE86012675.

Automated Image Analysis (AIA) and Scanning Electron Microscopy (SEM) was developed and applied to the characterization of mineral matter in two series of processed coals. Fundamental factors for the application of image analysis to the characterization of minerals in coal which were addressed include development of chemistry definitions for classification of minerals in coal, sampling design, characterization of mineral matter mass distributions by size and type for both raw and processed coals, and AIA overestimation of pyritic sulfur. Two methods of developing a chemistry definition file were described. A priori class definition and autoclassification were discussed as complementary procedures for writing an initial definition file, and guidelines were suggested for evaluating and revising chemistry files. A formula was developed for designing AIA procedures so that adequate sample area and particles may be analyzed to produce reliable and reproducible results. An example was also presented of using actual particle count to determine precision on a category-by-category basis. Factors leading to AIA overestimation of pyritic sulfur by as much as 50% were evaluated. Area inflation due to threshold setting was shown to cause overestimation of less than 10%. Preferential settling of pyrite particles was shown to be a minor effect (6%) for 200 mesh coals and can be avoided by proper sample preparation. Porosity in large particles of pyrite was found to be the most significant reason for overestimation of pyrite.

37293 (PB—86-188604/XAB) **Survey of the abrasion indices of coals from colliery-product samples.** van Vuuren, M.C.J. (National Inst. for Coal Research, Pretoria (South Africa)). 1985. 22p. (COAL—8504). NTIS, PC A04/MF A01.

With an ever-increasing production and the associated handling and communition of coal, more attention is now being given to the problems related to the abrasive properties of coal. The Institute has undertaken a comprehensive survey of the abrasive properties of colliery product samples that are of interest to both coal producers and consumers. On the same samples, the quartz and pyrite contents were determined and, from the carbonate contents of equivalent colliery products, calcite (the most predominant carbonate mineral) values were calculated to represent the range of carbonate minerals in coal.

37294 (PB—86-192341/XAB) **Distribution patterns relating to the proximate analysis of South African coals and their use as a basis for the interpretation of thermo-gravimetric data.** Saayman, C.H. (National Inst. for Coal Research, Pretoria (South Africa)). 14 Dec 1984. 44p. NTIS, PC A05/MF A01.

The report presents an analysis of South African coal deposits and their distribution patterns. Their use as a basis for the interpretation of thermo-gravimetric data is also covered.

37295 (STEV-TORV—86-5) Quality determination of peat by means of a 19-channel near infrared instrument. Johansson, E.; Persson, J.Aa.; Olsson, R. (Statens Lantbrukskemiska Lab., Umeaa (Sweden); Statens Energiverk, Stockholm (Sweden)). 1985. 47p. (In Swedish). (SLL—41). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752276.

Near infrared reflectance (NIR) spectrophotometry is demonstrated to be useful for the determination of water and calorific value in peat. Partial least squares modelling in latent variables (PLS) has been used to correlate NIR spectra to water content and calorific value. Separate calibrations for water and calorific value has been compared with the simultaneous calibration for both properties. The result of the simultaneous calibration for water is better than the result obtained in the separate calibration, a result that indicates that the inclusion of an extra meaningful parameter will stabilize the calibration. A number of other interesting parameters, ash content, carbon - hydrogen, - nitrogen content, R-value and volume weight has also been determined with NIR. Of these carbon content, nitrogen content and R-value are well determined with NIR while the results for ash content, hydrogen content and volume weight are poor. (author).

37296 Coal liquefaction by molybdenum catalyzed hydrogenation in the absence of solvent. Derbyshire, F.J.; Davis, A.; Lin, R.; Stansberry, P.G.; Terrer, M.T. (Pennsylvania State Univ., University Park, USA). *Fuel Processing Technology;* **12**: 127-141(Mar 1986). (CONF-8506112—).

From US/France joint seminar on coal chemistry; Marseille, France (1 Jun 1985).

Dry catalytic hydrogenation, using an impregnated molybdenum catalyst, has been used to explore the processes of coal liquefaction and their relation to coal structure. It was found that for high activity the molybdenum must be present as MoS/sub 2/ and that the conditions used for impregnation can strongly influence catalyst dispersion and activity. At temperatures of 400 C and lower, a subbituminous coal was more readily converted to liquid products and gases than a coal of bituminous rank. Examination of reacted coals by reflected fluorescent light microscopy showed a close correlation between the yield of extractable liquids and the maximum intensity of vitrinite fluorescence. The fluorescence appears to be directly related to the liberation of relatively low molecular weight species within the coal structure. Coal pretreatment by low-temperature dry hydrogenation, prior to higher temperature liquefaction in the presence of solvent, improved the overall conversion and product selectivity of both bituminous and subbituminous coals. It is suggested that subtle control of the initial conversion reactions can lead to more efficient liquefaction of coals of different rank. 2 figs., 7 tabs., 21 refs.

37297 Determination of alcohols, phenols, and carboxylic acids using phosphorus-31 NMR spectroscopy. Schiff, D.E.; Verkade, J.G.; Metzler, R.M.; Squires, T.G.; Venier, C.G. (Department of Chemistry and Ames Laboratory, Iowa State University, Ames, Iowa 50011). *Applied Spectroscopy;* **40**: No. 3, 348-351(Mar 1986). Contract W-7405-ENG-82.

Derivatization of compounds containing -OH groups can be accomplished quantitatively with 1,3,2-dioxaphospholanyl chloride. The chemical shifts of phosphorus in the derivatives clearly differentiate alcohols from phenols and carboxylic acids. Quantitation is obtained by use of ^{31}P FT-NMR spectroscopy in the presence of 2,2,6,6-tetramethylpiperidinyloxy free radical to shorten relaxation times. Compounds with phosphorus chemical shifts differing by as little as 0.1 ppm can be separately determined.

37298 Methanol chemical ionization of ketones and aldehydes. Miller, D.J.; Hawthorne, S.B. (Univ. of North Dakota, Energy Research Center, Box 8213 Univ. Station, Grand Forks, ND). pp 224-225 of Proceedings of the 33rd annual conference on mass spectrometry and allied topics. East Lansing, MI; American Society for Mass Spectrometry (1985). (CONF-8508123—). Contract FC21-83FE60181.

From CLIMA 2000 conference; Copenhagen, Denmark (25 Aug 1985).

The identification of many organic species in coal-derived products is difficult because of the extremely complex nature of these samples, the lack of appropriate standard compounds, and the often ambiguous nature of conventional electron impact (EI) spectra. Chemical ionization (CI) mass spectrometry using class-specific reactions between reagent ions and sample species has been used to identify several compounds in complex mixtures including aromatic amines, alcohols, ethers, carboxylic acids, and alkyl benzene isomers. New chemical ionization mass spectra of aldehydes and ketones using methanol as a reagent gas are reported here. The mass spectrum of the aldehydes and ketones studied shows a pseudomolecular ion at $[M+H]^+$, the addition of $[CH_3OH_2]^+$ and dimer formation with the addition of H^+. Aldehydes also show a loss of water at M-17. Chemical ionization mass spectra of sample aldehydes and ketones were generated using a Hewlett-Packard model 5985B gas chromatograph/mass spectrometer in the chemical ionization mode. The source temperature was 200°C, the ionizing voltage was 100 eV, and the scan range was m/z 98-500. Approximately 300 ng of each test species was introduced into the source chamber through the chromatographic column. The source pressure was maintained at approximately 0.2 torr by introducing methanol or mono-deuterated methanol (CH_3OD, 99.9% isotopically pure) directly into the source chamber. Major reagent ions under the described conditions were $[(CH_3OH)/sub\ n/H]^+$ and the same species after the loss of H_2O, $[(CH_3OH)/sub\ n/H\text{-}(H_2O)]^+$, with n = two and three as the predominant species. Comparable reagent ion species were generated from the CH_3O reagent gas.

37299 The effect of surface active additives on coal/water slurry rheology. Casassa, E.Z.; Parfitt, G.D.; Rao, A.S.; Toor, E.W. (Carnegie-Mellon Univ., Dept. of Chemical Eng., Pittsburgh, PA 15213). pp 10 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—). Contract FG22-81PC40285.

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

Rheological behavior, sedimentation stability and electrophoretic mobility of four bituminous coals, Pittsburgh Seam #8, Illinois #6, San Juan and Hiawatha, have been measured in water and in solutions of simple well-characterized surfactants: non-ionic Triton X-100; cationic hexadecyltrimethyl ammonium bromide; and the anionics sodium dodecyl sulfate and Aerosol OT. Slurry rheology and stability depend upon coal particle surface charge. If surface charge is high, viscosity and yield stress tend to be low, but sedimentation stability is poor. If surface charge is near zero, agglomeration of coal particles occurs, leading to non-Newtonian behavior and high viscosity but good sedimentation stability. The surface charge developed in a coal/water slurry depends upon the degree of wetting of the powder, upon soluble inorganic ions derived from ash, and upon the inherent charge of the carbonaceous portion of the coal surface. Additives can be chosen to modify surface charge and improve slurry rheology.

0108 Waste Management

REFER ALSO TO CITATION(S) 37342, 37839, 37854, 38197, 38531, 38797, 38828, 38958

37300 (CONF-8509275—, pp 113-120) Study of peat particle precipitation based on surface load theory. Jaervinen, T.; Aho, M. (Technical Research Centre of Finland, Jyvaeskylae, Finland. Domestic Fuel Lab.). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

A consequence of the peat production in Finland is the effluents given off by production sites. Solid matter content of running water from production fields is a most important factor affecting the lower water course. Finnish Water Board has issued design guides for the construction of precipitation basins in peat fields. The design parameters have been taken mostly from the guides for waste water treatment plants for the community. In order to make these values more suitable for peat production conditions, the Domestic Fuel Laboratory of VTT has done research on the precipitation properties of peat particles based on surface load theory. Settling experiments have also been done on a laboratory scale. When

the settling properties of peat particles based on surface load theory have been studied, the most important thing is to determine the real particle size in the water surroundings. The particle size determines the settling velocity, which is decisive for the precipitation results. With the aid of settling velocity and surface load theory, the minimum size of the precipitation basin may be calculated. It is possible to estimate the settled quantity of sludge and the critical velocity of flow to set the sludge in motion. Settling experiments were carried out in a laboratory experimental basin with effluent water from production sites both in stable and flowing conditions. A partition was also put in the basin and this was also tested. These results were compared with precipitation experience in the field. The research results provided a design base for settling basins according to particle size analysis. With 2 refs. (author).

37301 (CONF-8509275—, pp 121-130) **Some concepts to prevent the environmental effects of the peat production.** Selin, P.; Nyroenen, T. (VAPO OY, Jyvaeskylae, Finland. Research Dept.). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

The environmental problems arising from peat production can be reduced considerably by correct planning of the production area. The production method and the machinery needed also have to be considered during the planning phase. If the production area is located near dwellings, the noise and dust may cause harm, while consideration must also be given to transportation of peat and the fire hazard during the production period. According to the present investigations, the most serious water impact is caused by the solid matter (small peat particles) flowing with the waters from the production area. To prevent this impact, the length and the slope of the ditches must be designed so that the water flow in the ditches, even during heavy precipitations, is as steady as possible. The volume of the ditches can be utilized to settle the solid matter, as a drainage system must be constructed in every case. The removal of the slurry from ditches is easier than from large settling ponds. The shape and the size of the ponds, however, must also allow for easy cleaning. This prevents the decomposition of the organic matter in the ponds. There are some additional ways to prevent the escape of solid material, such as a peat filter trench ditches and special splints. With 7 refs and 5 figures. (author).

37302 (CONF-8509275—, pp 137-145) **Waste water characteristics of five peat dewatering processes.** McKim, M.P.; Smith, D.K.; Lindsay, J.A.; Day, J.K. (Ontario Research Foundation, Mississauga, Ontario, Canada. Sheridan Park Research Community; Environment Canada, Cartmouth, Nova Scotia, Canada). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

The exploitation of Canada's vast peat reserves through wet mining and subsequent dewatering to produce a peat derived fuel has received increasing interest. Five dewatering technologies for the production of peat derived fuel are discussed in this paper. Three processes are based on thermal pretreatment of the peat, wet oxidation by the Ontario Research Foundation, wet carbonization by the Institute of Gas Technology and the 'low severity' process of the Universite de Sherbrooke. The two non-thermal processes are McGill University's dewatering using microbial products and the rotary press developed by the Centre de recherche Industrielle du Quebec. As peat contains up to 90% moisture, the dewatering of peat results in the discharge of copious wastewater. The principal objectives of this work was to characterize these effluents. The chemical and biological characteristics of the wastewaters discharged by the five peat dewatering processes varied greatly. The wet oxidation and wet carbonization produced strongly coloured effluents with high levels of biochemical oxygen demand, ammonium and phenolic compounds. Some acid extractable priority pollutants and toxic heavy metals were detected in these effluents, but not at alarming levels. Each of the three thermal processes were reported to have effluents with a high acute toxicity in the Microtox (TM) bioassay and to fish. However, they are likely amenable to biological wastewater treatment. (author).

37303 (CONF-8509275—, pp 211-219) **Residues from peat burning - disposal and utilization.** Hartlen, J.; Nilsson, G. (Swedish Geotechnical Inst., Linkoeping, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

A successive changeover from oil burning to solid fuel burning is in progress in many countries. The solid fuels in question in Sweden are primarily coal and peat. In order to clarify the environmental effects of the changeover, two major studies, Project Coal-Health-Environment (KHM)(1983) and Project Peat-Health-Environment (THM)(1985), have been carried out in Sweden. In both of these projects the subject of residues has been treated as a subproject with the main author of this paper as project leader. With 3 figures, 3 tables and 6 refs. (author).

37304 (CONF-8509275—, pp 379-389) **Purification of effluents from the wet-carbonization process of peat.** Kyiloenen, H.; Peltola, T. (Technical Research Centre of Finland, Espoo, Finland. Lab. of Fuel Processing and Lubrication Technology). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Effluents are a great problem in the wet-carbonization process of peat. A wet-carbonization plant, capacity 100000 t/a of PDF briquettes (moisture 10% w/w), produces about 3600 m^3/d of waste water, the dry matter content of raw peat being 9% w/w. The BOD_7 value of the effluent is 7000-8000 ppm. The fermentation of wet-carbonization effluents to fodder protein was studied in spring 1984. A corresponding process, so-called Pekilo process, is applied in the purification of effluents from a sulphite cellulose mill in Finland. A BOD_7 reduction of as high as 84% was achieved in the Pekilo fermentation of wet-carbonization effluents. About 3 kg of Pekilo product with about 50% w/w protein content could be produced from one m^3 of effluent. Anaerobic purification of wet-carbonization effluents was studied in a laboratory reactor and in pilot-scale reactors at the Haukineva wet-carbonization demonstration plant in autumn 1984. A BOD reduction of > 95% was achieved by the laboratory reactor and about 75% by the pilot-scale reactors. Gas production was at its best > 3 l of biogas (79% CH_4, 21% CO_2) from one litre of effluent. The profitability of the purification process is dependent on the price of product and on the capacity of the wet-carbonization plant.

37305 (CONF-8509275—, pp 391-394) **Reduction of environmental consequences in space heating by using pellet burning technology.** Oravainen, H. (Technical research Centre of Finland, Jyvaeskylae, Finland. Domestic Fuel Lab.). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Space heating with different peat fuels has been studied at the Domestic Fuel Laboratory of the Technical Research Centre of Finland. Special attention has been paid to establishing the environmental consequences of different fuels and methods of combustion. In addition to the usual flue gas measurement (CO_2, O_2, CO), analysis also included hydrocarbons (Csub(x)Hsub(y)), nitrogen oxides (NOsub(x) as well as polycyclic aromatic hydrocarbons (PAH). Flue gases were continuouly analysed except PAH analysis, which were made of the taken samples. The combustion of peat pellets in a pellet burner and peat briquettes on a grate were studied. Comparisions between light fuel oil combustion in a modern oil burner and combustion of wood and bark pellets in a pellet burner were made. Peat briquette burning is difficult to deal with as harmful environmental compounds and foul peat odours are released in the flue gases. However fuel pellet burning in a pellet burner was found to be clean.

37306 **(DOE/PC/80512—T5) Anaerobic SBR treatment of coal conversion wastewaters. Third quarterly report.** Ketchum, L.H. Jr. (Notre Dame Univ., IN (USA). Dept. of Civil Engineering). 20 Jun 1986. Contract FG22-85PC80512. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011990.

The 2-L acclimation studies and serum-bottle screening tests described in the preceding progress report are being continued. The two 4-L automatically operated AnSBR's have been started. Preliminary fundings have been summarized in this progress report.

37307 **(ECN—86-047) Physical and chemical characterization of 50 pulverized coal ashes with respect to partial cement replacement in concrete.** Van der Sloot, H.A.; Weijers, E.G. (Netherlands Energy Research Foundation, Petten). Apr 1986. 26p. (CONF-8604215—1). ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

From 2. international conference on the use of fly ash, silica fume, slag and natural pozzolans in concrete; Madrid, Spain (21 Apr 1986).

Presented at the 2. International conference on the use of fly ash, silica fume, slag and natural pozzolans in concrete, Madrid, 21-25 April 1986.

Physical and chemical characterization of 50 pulverized coal ashes from Dutch, Belgian and German installations has been carried out to identify the parameters that have to be kept under control, when pulverized coal ashes are to be used as partial cement replacement in concrete. For a good workability of fly ash/cement mortars the particle size and the carbon content are important. By performing a mortar flow test (Heagermann) upon delivery exterme ashes can be easily eliminated. The compressive strength is largely determined by the fineness of the ash (weight fraction below 20 micron). A direct effect of carbon content on strength development is not observed, but a reduction in mortar slow due to carbon leads to loss in strength, while the workability has to be adjusted. Size distribution measurement by optical methods is recommended as the relevant part of the ash size distribution cannot be properly assessed by sieve methods. The net contribution of fly ash to the compressive strength of a fly ash/cement (20/80) mortar exhibits a minimum at 14 days curing, which is common to all 50 ashes studied. Improvements in ash quality as obtained from pulverized-coal fired installations can be achieved by improvements in coal milling and optimizing ash collection. 6 figs., 4 tabs., 19 refs.

37308 **(EUR—8800-EN) Recovery of energy by fluidised combustion of waste material arising from coal mining and coal processing. Final report.** (Commission of the European Communities, Luxembourg. Directorate General Information Market and Innovation). 1984. 83p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Technical coal research.

The feasibility of recovering, by fluidised bed combustion, the useful heat from wastes arising from coal mining, coal conversion and coal combustion has been considered. Three feedstocks, a fine ash waste (65% ash), run-of-mine coal (42% ash) and coarse washery discard (80% ash), were selected for pilot plant investigations. These investigations included fuel storage and feed to the combustor together with assessment of material behaviour in the fluidised bed combustor. Fluidised bed cold models were used to investigate the behaviour of the ash derived from coarse feedstocks (up to 25 mm in size) and in particular to assess segregation and defluidisation of the large ash particles. These cold models were then used to develop a spouted-fluidised bed system to control defluidisation of large ash particles. A series of combustion trials was undertaken using two, 0.3 m square and 0.6 m square, fluidised bed combustors, in which the three selected feedstocks were burned. During these trials, in which approximately 200 tonnes of material was burned, a wide variety of operating parameters was investigated. These included fuel size, bed temperature, bed height, limestone addition, fines recycle, fluidising velocity and the method of air distribution. The test work showed that fluidised bed systems can be designed to burn fine wastes (minus 0.5 mm size) and coarse wastes (up to 25 mm size) efficiently. (orig.).

37309 **(IS-M—565) Application of current utilization technologies to coal solid wastes of the future.** Burnet, G.; Murtha, M.J. (Ames Lab., IA (USA); Iowa State Univ. of Science and Technology, Ames (USA). Dept. of Chemical Engineering). 1985. Contract W-7405-ENG-82. 15p. (CONF-850982—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011434.

From 2. annual Pittsburgh coal conference; Pittsburgh, PA, USA (16 Sep 1985).

US utilities currently generate over 100 million tons of solid wastes per year. There is no single answer for the effective management of these wastes, but utilization to yield products that can be manufactured and marketed successfully is becoming increasingly attractive as an alternative to disposal. Most established uses are construction related and include road base materials, structural fill, cement admixtures, light-weight aggregate and land reclamation. Other relatively high technology applications such as mineral recovery and the separation of magnetite and censopheres are less well developed but offer significant opportunities. An important future consideration is the utilization of wastes resulting from new energy technologies and having different characteristics. Technologies included are fluidized bed boilers, flue gas dry scrubbers, and special multistage combustion burners. These developments will lead to replacement of pulverized coal fly ash with new ash forms which contain highly reactive materials such as alkaline oxides and sulfites. This paper briefly reviews current utilization technologies and examines their application to the solid wastes expected in the future.

37310 **(IS-M—583) Stabilization of coal cleaning waste by a sintering process.** Gokhale, A.J.; Burnet, G. (Ames Lab., IA (USA); Iowa State Univ. of Science and Technology, Ames (USA). Dept. of Chemical Engineering). 1986. Contract W-7405-ENG-82. 22p. (CONF-8604188—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011402.

From 98. annual meeting of the Iowa Academy of Science; Waverly, IA, USA (25 Apr 1986).

Solid waste from coal cleaning poses a significant environmental problem. In this work, the waste is stabilized by aggregation and sintering to form impervious, vitreous granules. The result is an inexpensive method for eliminating dusting, leaching, and smoldering at waste disposal sites. The process utilizes the fuel and sintering materials inherently present in the waste which, in this study, came from the River King Coal Preparation Plant, in Freeburg, IL where the coal and waste are similar to those from Iowa mines. Characterization and grinding of the waste, the formation and testing of green pellets for strength and durability, the design and operation of a fixed bed sintering furnace, and preliminary evaluation of the sintered granules formed are discussed.

37311 **(LBL—21355) Selected organic pollutant emissions from unvented kerosene heaters.** Traynor, G.W.; Apte, M.G.; Sokol, H.A.; Chuang, J.C.; Mumford, J.L. (Lawrence Berkeley Lab., CA (USA); Battelle Columbus Labs., OH (USA). Analytical and Structural Chemistry Center; Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). Mar 1986. Contract AC03-76SF00098. 22p. (CONF-860606—8). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011553.

From Air Pollution Control Association annual meeting and exhibition; Minneapolis, MN, USA (22 Jun 1986).

This study has confirmed the results of other studies, i.e., that the kerosene combustion process can emit PAHs and nitrated-PAHs. In addition, kerosene heaters were found to emit many other organic compounds, including aliphatic hydrocarbons, alcohols, and ketones; phthalates; alkyl benzenes; and pentachlorophenol. Additional analysis is needed to correlate these results with health-effects data to determine the risk associated with these organic emissions. PAH and nitrated-PAH emissions are sufficiently important to justify additional quantitative studies; furthermore, examinations of other organic compounds of toxicological significance and of unvented combustion sources should be expanded. One very important observation of this study was that some estimates of the indoor reactivity of SVOCs were higher than 2 h^{-1}. This implies that reactivity rates for some SVOCs are more important than ven-

tilation rates for determining indoor concentrations. Clearly, this indicates that future studies must quantify the indoor reactivity process for indivisual SVOCs in order to gain insight into potential indoor exposures to these compounds.

37312 **(LBL—21372) Chemistry of a flue gas combined NO/sub x/ and SO_2 scrubber employing ferrous cysteine additives.** Tu, M.D.; Chang, S.G. (Lawrence Berkeley Lab., CA (USA)). Apr 1986. Contract AC03-76SF00098. 23p. (CONF-860447—5). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012013.

From American Institute of Chemical Engineers spring national meeting; New Orleans, LA, USA (6 Apr 1986).

Employment of ferrous cysteine additives creates different and simpler scrubber chemistry, compared to Japanese processes using ferrous chelates such as Fe^{2+}(EDTA). Instead of being mainly converted to nitrous oxide, nitric oxide in flue gas can be concentrated and/or reduced to nitrogen gas, and production of dithionate ions and nitrogen-sulfur compounds in scrubbing systems can be suppressed or avoided. Fixation of nitric oxide can take place by rapid reaction with ferrous cysteine to form solid cystinatodinitrosyl iron (II) which can release NO upon heating. Cysteine can rapidly reduced ferric to ferrous ions while itself is oxidized to form cystine. The latter can be reduced back to cysteine by SO_2.

37313 **(ORNL/TM—9946) Characterization and disposal of by-product elemental sulfur.** Boegly, W.J. Jr.; Francis, C.W.; Watson, J.S. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 94p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012454.

Large quantities of commercial-grade elemental sulfur are potentially available from coal conversion facilities. However, the demand for sulfur is highly variable, and there may be times when the sulfur produced cannot be marketed. If this were the case, the sulfur would have to be disposed of as a waste product. The purpose of this investigation was to evaluate the potential problems related to land disposal of by-product sulfur. Samples of by-product sulfur obtained were from Stretford sulfur recovery units at coal conversion pilot plants analyzed, and subjected to leaching tests. The results indicate that leaching of trace metals from by-product elemental sulfur should not be a problem but that leaching of sulfate and vanadium may be a concern. Vanadium concentrations greater than 1000 mg/L, sulfate concentrations greater than 25,000 mg/L, and pH values lower than 4 were measured in the leachates. Leaching tests on a mixture of gasifier ash and by-product elemental sulfur indicated that co-disposal of these two materials would result in highly acidic leachates, which over time may contain elevated levels of cadmium, zinc, and nickel.

37314 **Removal of sulfur and nitrogen containing pollutants from discharge gases.** Joubert, J.I. (to Dept. of Energy, Washington, DC). US Patent 4,587,113. 6 May 1986. Filed date 8 Feb 1985. vp.

A process is described for the removal of sulfur oxide-containing pollutants from a gas flow including entrained ash which consists of: entraining finely divided, unsupported oxide of copper powder in the gas flow to react with the sulfur oxide containing pollutants and form a sulfate of copper in mixture within the powder. The finely divided oxide of copper powder has an average particle size of less than 30 microns; separating the powder and ash from the gas. The powder and ash are contracted with oxide of sulfur gas to sulfate substantially all of the oxide of copper in the powder. The sulfated powder and ash are contacted with aqueous solvent to dissolve the sulfate of copper into solution while ash remains as solid. The liquid solution containing sulfate of copper is separated from the solid ash. The liquid solution is spray dried to form fine particles including a sulfate of copper. The sulfate of copper particles is heated to a sufficient temperature to decompose the sulfate of copper to a finely divided oxide of copper powder and an oxide of sulfur gas. The finely divided oxide of copper powder is returned into contact with the gas flow; and a portion of the oxide of sulfur gas is recycled into contact with the powder and ash.

37315 **Characterization and catalytic activity of coal mineral matter. 2. Hydrodesulfurization of thiophene.** Johannes, A.H.; Hamrin, C.E. Jr. (Oklahoma State Univ., Stillwater, USA). *Fuel Processing Technology;* **13**: No. 1, 17-39(Apr 1986).

Intrinsic catalytic activity was evaluated for nine low-temperature ash samples (LTAs) from U.S. coals, a sample of SRC solids, and reference constituents ofcoal for the hydrodesulfurization (HDS) of thiophene. A pulse micro-reactor, gas-ghromatograph system was used to determine conversion by measuring the C/sub 4/s produced at 673 K. Activity ranking placed Kentucky Homestead as the best HHD catalyst by a factor of 14.3 times the activity of the lignite, which gave the lowest conversion. SRC solids from a Pittsburgh seam coal were evaluated and showed moderate HDS activity. This activity was similar to that of the mineral matter of two other Pittsburgh seam coals (Ireland and Bruceton). The catalytic activity of the LTAs was much smaller than measured conversions using a commercial cobalt molybdate catalyst. The SRC solids gave the highest hydrogenation activity (HA) of all the LTAs tested. The LTAs were found to be very poor hydrogenation catalysts. The worst HDS catalysts, lignite, gave the highest HA while Kentucky No. 11 had the lowest HA activity. More than 95% of the products were butenes or 1,3-butadiene. Surface area for the LTAs increased after catalyst testing, and the HDS activity correlated strongly with surface area while hydrogenation activity showed no such correlation. Favorable element correlations showed potassium to be the most favored for predicting HDS activity. The potassium in the LTAs was present as illite or feldspar. Results are also given for several reference clays and a synthetic mixture of mineral matter constituents. 12 tabs., 10 figs., 19 refs.

37316 **A systems study for the removal, recovery and disposal of carbon dioxide from fossil fuel power plants in the US.** Steinberg, M.; Cheng, H.C. (Brookhaven National Lab., Upton, LI, NY). *Proceedings, Annual Meeting, Air Pollution Control Association;* **3**: 1-24(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

Removal and recovery of CO_2 from the stacks of fossil fuel plants is feasible by absorption/stripping with an efficient solvent system. Integration of the power plant with the CO_2 removal and recovery process through the use of low-pressure steam from the power plant's turbine to supply the necessary heat for solvent regeneration prevents much of a loss in electrical power generation efficiency. For 90% CO_2 removal, the coal-fired power plant's efficiency declines from 38% to 35%. It appears feasible to pump the recovered liquid CO_2 by 6-inch pipeline from each power plant to collection centers where it is transported by a 36-inch line to the final disposal site. Three ways of disposing of recovered CO_2 have been considered; ocean injection at 500-m-depth at a distance of about 100 miles from the coast, storage in depleted oil and gas wells, and storage in excavated salt caverns. Some experimental work may be necessary to select an optimum depth for injection of CO_2 for ocean disposal.

0109 Environmental Aspects

REFER ALSO TO CITATION(S) 37275, 37302, 37333, 37365, 37366, 37391, 37836, 38088, 38941

37317 (CONF-8509275—, pp 21-24) **Peatland and its environment as a living ecological entity.** Sjoers, H. (Uppsala Univ. Sweden. Inst. of Ecological Botany). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

A.K. Cajander, in Finland 1913, regarded peatlands as geographical units consisting both of a surface characterized by microtopography and vegetation, and a pile of peat characterized by its stratigraphy. It may be added that natural peatlands also should be characterized by their hydrology, which may or may not be dependent on that of their mineral surroundings or adjacent open waters, as well as on the climate and on the topography of the peatland itself. In modern language, peatlands are ecosystems, of

variable size and complexity. Cajander distinguished two levels of complexity, the unit areas called Moortypen (later: mire site types or mire elements), and the large Moorkomplexe. Russian authors have added a still larger unit called mire massifs or mire landscapes. On the other hand, individual surface structures such as hollows, hummocks and kermis, flarks and strings, pounikkos and palsas, peat polygons, etc., combine, in the mire site dimension,into often distinct patterns. These patterns display astonishing orderliness, combined with infinite variation in details. A peatland with natural hydrology and, in consequence, natural or near-natural vegetation may be called a mire. Nearly all human development of mires, whether for agriculture, forestry, peat extraction, or water storage, first of all interferes with hydrology and, next, with vegetation. Once the hydrology is changed, the peatland is irreversibly converted into a different ecosystem. There is no 'multiple use' of peatlands; the only way to combine exploitation of any kind with partly remaining ecological diversity is to set aside a very large and representative area of mires unexploited. In this process, conservation must claim priority.

37318 (CONF-8509275—, pp 59-68) **Development of environmental protection criteria and technologies for peat harvesting, processing and utilization in Canada.** Guilcher, M.P. (Environment Canada, Dartmouth, Nova Scotia, Canada. Environmental Protection Service). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Environment Canada has carried out literature searches and bench scale research and published reports on studies which identify pollution potentials and abatement technologies applicable to peat harvesting and beneficiation. Major thrusts have been towards laboratory and field work to chemically characterize various waste streams and to determine their treatability. Emphasis has been on waters drained from bogs and peat pressate associated with dewatering or pretreating peat. This work has been largerly supported by the Program of Energy Research and Development (PERD) administered by the Department of Energy, Mines and Resources. This paper describes the work to date and future activities. With 9 refs. (author).

37319 (CONF-8509275—, pp 69-85) **Drainage water quality of peat mining areas.** Johansson, J.Aa.; Olofsson, H. (Uppsala Univ. Sweden. Inst. of Limnology). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

The drainage water quality from a peat mining area was characterized during the first year after ditching when the mire was prepared for production. The quality of the drainage water from areas where peat production had started is also described. After ditching the level of the groundwater table was almost constant during the first year. No changes of the chemical composition of the groundwater of the peat aquifer after ditching could be documented. The content of suspended matter in the drainage water was high during periods of great flow and when ditching occurred. The concentration of nitrogen and phosphorus was positivly correlated to suspended solids. When the concentration of suspended solids was high most of the nitrogen and phosphorus was associated to particles. The concentration of chemical constituents during the first year after ditching can be predicted from the chemical composition of peat, groundwater and precipitation. The concentration of suspended solids, nitrogen and phosphorus in the drainage water from peat mining areas of different age was more than 5 times larger than corresponding concentrations in the recipient. The concentration of ammonium-nitrogen was less than 1 mg/l during the first year after ditching and 2-3 mg/l in drainage water from areas where peat production had started. With 7 figures, 4 tables and 8 refs. (author).

37320 (CONF-8509275—, pp 87-99) **Nutrient transport in runoff water from Finnish peatland drainage and peat mining areas.** Sallantaus, T.; Paetilae, A. (Helsinki Univ. Finland. Dept. of Limnology; Helsinki Univ. Finland. Dept. of Peatland Forestry). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Eleven disturbed peatland watersheds, both drainage areas and areas under active peat production, were monitored. Mean total phosphorus concentration in runoff varied 30-200 μg P/l and mean inorganic nitrogen 300-3000 μg N/l. Inorganic nitrogen was mostly ammonium, and made 50-70% of the total nitrogen. These nutrient concentrations were high compared to values in a natural peatland; 18μg P/l and 30 μg N/l. The highest annual P-discharge, 120 kg P/km^2, was observed immediately after drainage and the highest inorganic nitrogen discharge, about 1000 kg N/km^2, during peat mining. With 27 refs. (author).

37321 (CONF-8509275—, pp 101-111) **Peat deposits drainage and environment.** Kolesin, V.N.; Yanushevskiy, V.V. (RSFSR Ministry of the Fuel Industry; Moscow Branch of VNIITP). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

The influence of peat deposits drainage on the hydrological conditions of adjacent territories, productivity of biocenosis, hydrological and hydrochemical regimes of water catching basins have been studied. In sand sediments, characteristic for Meshtsherskaya lowland, the zone of influence of drainage spreads into the territory up to 3 km deep. In the zone of influence of peat deposits drainage the development of bog formation processes gives up, the microclimate and soil aeration get better, which contributes to increasing productivity of forest plantations, increasing yield capacity of agriculture. The extent of the zone of drainage influence can be extended significantly by drainage of peat deposits, situated near by, and additional lowering of ground water level. On the cut-over surfaces of peat deposits, the simple or complex bog biotopes renew naturally and are more productive than the biocenoses that existed before drainage and development of peat deposits. The sewage from the drainage net of productional areas of high-moor peat deposits are characterized by low mineralization (down to 100 mg/dm^3 of mineral components), high content of suspended substances (up to 100 mg/dm^3) and diluted substances (up to 300 mg/dm^3). These sewages do not influence the hydrochemical regime of water catching basins. The amount of catching some ingradients by sewage from the drainage net of peat enterprises depends on the period of the year. More than 60% of its annual amount belongs to the spring flood. The same is true for the natural sewage from peat enterprises. The many-year observations show, that the average annual sewage in the rivers of Meshtsherskaya lowland did not change under the influence of drainage of peat deposits. (author).

37322 (CONF-8509275—, pp 147-152) **Effects of mire drainage and peat extraction on benthic invertebrates and fish.** Olsson, T.I.; Naeslund, I. (Umeaa Univ. Sweden. Dept. of Ecological Zoology). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

This presentation deals with the effects mire drainage and peat extraction have on the aquatic fauna of recipient streams. Most Swedish recipient streams are small with a benthic fauna consisting of stoneflies (Plecoptera), mayflies (Ephemeroptera), caddisflies (Trichoptera), blackflies (Simuliidae), chironomids and beetles (Coleoptera). Brown trout (Salmo trutta) and sculpins (Cottus gobio) normally dominate the fish fauna. In Sweden the following changes in water quality as a result of peat exploitation have been suggested: 1 Acidification, 2 Increased water flow fluctuations, 3 Increased transport and sedimentation of organic and inorganic material. So far the problems with acidification and increased flow fluctucations have been of minor importance. However, the increased transport and sedimentation of organic and inorganic material occurring in recipient streams due to mire drainage and peat extraction have an obvious effect on different biotic levels. We have observed decreased species diversity and decreased total abundance of benthic invertebrates downstream from peat exploitation areas. With 3 refs, 3 figures and 3 tables. (author).

37323 (CONF-8509275—, pp 153) **Some environmental considerations in peat development in Indonesia.** Radjagukguk, B. (Gadjah Mada Univ., Yogyakarta, Indonesia. Dept. of Soil Science). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

37324 (CONF-8509275—, pp 154-163) **Environmental aspects of peat deposits development in USSR and the problems of its ecological and economic valuation.** Sokolov, B.N.; Yampolskiy, A.G. 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

In the USSR's peat industry the problems of production are solved with taking into account the ecological requirements, what promotes the development of rational use of nature. Environmental measures are united in three groups: keeping of a part deposits in natural undrained condition and some of them - in the kind of nature and wildlife areas; measures, fulfilled in correspondance with the environmental norms by development of peat deposits and in peat processing factories, which do not touch upon the technology of peat winning and processing; development of technological processes and equipment to minimize or exclude unutilized wastes and environment pollution. To the last group belongs also recultivation of cut peat production areas for utilization by land users for agricultural fields or forests. Environmental measures are described, and data about swamp objects of environment protection and recultivated milled over areas, are given. Some problems are observed. The first of them is criteria of peat deposits choice for conservation in natural condition. The positive role is marked of the methodics, developed by the body 'Torfgeologiya' and the Institute of Peat of the Academy of Sciences of the BSSR. Peat complex utilization. Methods are discussed for determination of optimum thickness of bottom layer. The methods for determination of the economic efficiency of environment protection measures are being developed.

37325 (CONF-8509275—, pp 175-183) **Peat-bog converted back to lake by planned harvesting.** Pettersson, R. (Svenska Torv Skaane AB, Soesdala, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

In the heart of Skaane, there are two flatland lakes, the East and West Ringsjoen. 5000 years ago there was one more lake here. During thousands of years northern Ringsjoen has filled up to a raised peat-bog with an area of 400 ha and a depth of 3-5 m. The peat building vegetation through the ages has been dominated by Sphagnum, Carex and Eriophorum. The peat moss has been utilized as fuel and stable litter. Today the peat constitutes a raw material for growing substrates for horticulture, but is also used as fuel. Moreover farming is carried on in the outer parts of Roenneholmsmossen. Since 1939 the Swedish Peat Skaane Company has managed peat production and later substrate manufacturing at Roenneholmsmossen. About 100000 m^3 milled peat is produced anually. Large scale production of peat has taken place since 1963 by practising the highly mechanized PECO-method, which means a simultaneous lowering of the whole area 15-20 cm per annum. The peat level so far has been lowered by the exploitation about 2.5 m. The harvesting is calculated to continue another 10-15 years on an area that is gradually diminishing. In the final stage 0.5 m is left of the bottom peat layer. Roenneholmsmossen has an underlayer of limemud with elements of shells, and with sand in the edges. After exploitation Roenneholmsmossen is to be converted back to a lake.

37326 (CONF-8509275—, pp 243-250) **Dustfalls in peat production and the utilization of peat.** Vesterinen, R. (Technical Research Centre of Finland, Jyvaeskylae, Finland. Domestic Fuel Lab.). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Dustfalls in peat production depend upon meteorological factors, primarily upon the amount of rain, the direction and the velocity of the wind, and the amount of peat produced, as well as upon the methods of peat production. On the basis of measurements made, dustfall is greater in the vicinity of an area of milled peat production than in the vicinity of sod peat production. Dustfall is greater when pneumatic harvesting is employed. In two Finnish peat production bogs utilizing pneumatic harvesting, dustfall averages of 13.6 g/m^2 per month at Haapasuo and 7.2 g/m^2 per month at Laeynioensuo were measured. When the Haku-method is used there is an average of 6.5 g/m^2 per month. Total dustfall was higher in the immediate vicinity of a sod peat-fired district heating power plant, with an average of 7.3 g/m^2 per month. Dustfall in the neighbourhood of a heating plant depends on the amount of fuel used, the cleaning of the flue gases, the height of the stack, and meteorological conditions. The ash content of water insolubles decreases as the amount of settleable particulates increases. The tendency is the same in the neighbourhood of peat production, and at the heating plant (in the vicinity of the receiving station for peat), because the proportion of peat dust in the dustfall increases. With 2 refs. (author).

37327 (CONF-8509275—, pp 425) **Water balance of swamps in Jamaica.** Forsman, A. (Swedish Meteorological Inst., Norrkoeping, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Plans are under way to utilize the peat resources of two large swamps in Jamaica for electric power generation. The two swamp areas, Black River Morass and the Great Morass of Negril, are close to the sea and are subject to tidal effects. The bedrock is limestone and several streams as well as a number of springs feed the swamps with fresh water. The balance between these inflows and the evaporation losses from the swamps plus rainfall on the swamps control the delicate balance of fresh water and the exchange and intrusion of sea water from the Caribbean Sea into the swamps. After mining the peat the swamps will be converted into lakes. The evaporation losses will then undoubtedly change, and this in turn will influence the whole water balance. The crucial question is whether the evaporation losses will increase or decrease. In addition to the routine measurements of rainfall and streamflow, measurements have been conducted for one year of pan evaporation and of the heat balance of the swamps. The results of these investigations have been presented in the following reports: 'Summarizing report: Hydrology of the Negril Wetlands, pre and post peat mining conditions' by Forsman, A. and Haeggstroem, M. SMHI 1984, Norrkoeping, and 'Water Balance of the Great Morass of Negril and the Lower Morass of the Black River, Jamaica' by Haeggstroem, M. SMHI 1983, Norrkoeping. (author).

37328 (CONF-8605137—3) **Evaluating ecosystem response to toxicant stress: a state space approach.** Johnson, A.R. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 30p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011777.

From 10. symposium on aquatic toxicology and hazard assessment; New Orleans, LA, USA (4 May 1986).

Ecosystems can be regarded as complex biogeochemical systems maintained in a state of thermodynamic nonequilibrium by the flow of materials and energy. The state of such a system at any given time is generally assumed to be characterized by a finite set of variables. If these variables are taken to be the components of a vector, the instantaneous state of an ecosystem can be represented by a single point in an abstract multidimensional space. As an ecosystem undergoes changes in state, changes in the position of the corresponding vector will result, tracing out a state trajectory over time. Within the state space approach formulated above, the response of an ecosystem to a perturbation, such as the introduction of a toxicant, can be viewed as a displacement of the state vector away from its unperturbed trajectory. Such an approach was used to analyze data from a study of the response of experimental ponds and microcosms to chronic additions of a coal-derived synthetic oil. Ecosystem-level response surfaces and dose-response curves were derived based upon the average separation (distance of displacement) of exposed ecosystems relative to controls. The results exhibited patterns analogous to those observed in classical toxicology based on organismal response, and could be used to define accepta-

ble exposure conditions. The state space approach described here provides a coherent and objective framework for summarizing a large multivariate data set, and it should be of general use in providing both qualitative and quantitative descriptions of the behavior of perturbed ecosystems.

37329 **Elemental composition of suspended particulate matter from the combustion of coal and coal/refuse mixtures.** Norton, G.A.; DeKalb, E.L.; Malaby, K.L. (Ames Lab., IA). *Environmental Science and Technology;* **20**: No. 6, 604-609(Jun 1986). Contract W-7405-ENG-82.

Samples of suspended particulate matter in size fractions of >10, 3-10, 1-3, and <1 μm were collected from the stack of a 35-MW power plant when coal alone and mixtures of coal and refuse-derived fuel (RDF) were being combusted. Chemical analyses by X-ray fluorescence, neutron activation, and atomic absorption indicated that concentrations of As, Cd, Cu, Ge, Ni, Pb, Sr, and Zn increased by at least a factor of 2 with decreased particle size when both coal and coal/RDF mixtures were fired. In the smaller particle sizes, levels of Cd, Pb, Sb, Sn, and Zn were at least twice as high in the ash from coal/RDF combustion relative to the combustion of coal alone. Results from this study suggest that particulate emissions from firing coal/RDF mixtures are not sufficiently enriched in trace elements to pose any greater environmental concern than particulate matter from combusting coal only. 22 references, 1 figure, 7 tables.

37330 **Morphological and chemical characterization of iron-rich fly ash fractions.** Norton, G.A.; Markuszewski, R.; Shanks, H.R. (Ames Lab., IA). *Environmental Science and Technology;* **20**: No. 4, 409-413(Apr 1986). Contract W-7405-ENG-82.

Fly ash samples collected from the electrostatic precipitator of a coal-fire power plant were separated into relatively magnetic and nonmagnetic fractions. The magnetic portions of these samples were examined by scanning electron microscopy, optical microscopy, and X-ray diffraction. The fly ash particles in the magnetic concentrates were predominately spherical and were generally solid in cross section, although vesicular particles were common in the larger sizes (e.g., >50 μm). The larger particles also exhibited the most diversity with respect to internal morphology. A variety of dendritic growths were among the features observed. X-ray diffraction analyses revealed that the magnetic fly ash fraction was composed primarily of magnitude and less amounts of hematite. Results of this study suggest a potential for increasing ash density and purity by selecting a particle size range that will optimize these parameters. This in turn could make it more suitable for use as a heavy medium in physical coal beneficiation. 22 references, 9 figures.

37331 **Photofragment fluorescence as a sensitive probe for gas-phase alkali compounds and their photochemistry.** Oldenborg, R.C.; Baughcum, S.L.; Hof, D.E.; Winn, K.R. (Chem. Div., Los Alamos National Lab., Los Alamos, NM 87545). pp 339-346 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

Sensitive techniques are needed for the detection of highly corrosive gas-phase alkali compounds in coal gasifier gas turbine streams. The authors report on the use of photofragment fluorescence as a very sensitive, selective probe for alkali compounds. Photodissociation of a gas-phase alkali compound using a laser at suitably short ultraviolet (uv) wavelengths produces an electronically excited alkali atom. Detection of fluorescence from these excited atoms allows sensitive and quantitative density measurements of a compound while signal strength as a function of dissociation laser wavelength allows differentiation of compounds. The authors present here an evaluation of this approach based on the results of experiments to study the photodissociation of the alkali compound KCl. The KCl vapor was contained in a heated quartz cell and irradiated at 193 nm with an ArF laser and at other Raman-generated wavelengths. Emission at 766nm was observed from atomic potassium (4^2P^o) produced in the photodissociation process. The spectral dependence for the production of excited potassium atoms is distinct enough that discrimination from other compounds, such as KOH, appears likely. The atomic emission intensity quantitatively tracks the KCl density over at least 5 orders-of-magnitude. As little as 4×10^7 KCl molecules/cc, or a 0.5 ppb KCl concentration, can be measured on a single laser shot, making this a very sensitive diagnostic technique. Experiments on other alkali compounds are now in progress.

0110 Reserves And Exploration

REFER ALSO TO CITATION(S) 37294, 37323

37332 (CONF-8509275—, pp 29-41) **Peat in Sweden - an important energy resource - or just a parenthesis.** Franzen, L. (Goeteborg Univ. Sweden. Dept. of Physical Geography). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

The thesis deals with peat resources of Sweden and presents a new method to calculate peat resources with due attention to mire area, mean mire depth and peat volumes. The first chapters contain a general description of mire distribution in the world, Europe and finally Sweden with special regard to two test areas investigated. The method used to calculate peat resources is described, and the results from these calculations are shown in figures and tables demonstrating mire area, mire width, mire depth interpolated from own results. Finally an estimation of the available peat resources of the investigated areas and of total Sweden is made with due attention to fuel peat. The different factors reducing the total resource are discussed with special regard to mire area and mire depth. The results show that only a minor percentage of the total resources can be used for fuel peat at present. In the last chapter peat growth in relation to peat cutting is discussed. With 5 refs, 3 tables and 3 figures. (author).

0120 Mining

REFER ALSO TO CITATION(S) 37300, 37301, 37320, 37321, 37325, 37384, 38740, 38885

37333 **(CONF-8509275—) Proceedings: Peat and the environment '85.** (Swedish National Peat Committee, Hasselforg; Elmia AB, Joenkoeping (Sweden)). 1985. 394p. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

This publication consists of 49 contributions and 15 posters within the following subject areas: Selection of systems and site. Peat exploitation. Heat production. Health and safety. Sweden's peat energy programme. (BoK).

37334 (CONF-8509275—, pp 275-284) **Peat production studies and peat production monitoring in Sweden 1984.** Hansen, R. (Teknicus Interconsulting AB, Danderyd, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Teknicus Interconsulting AB has carried out studies of peat production since 1981. During the production seasons of 1983 and 1984, the author has been responsible for the management of the Swedish R and D project 'Peat production monitoring and studies'. Project objective. The ojective of the project was to carry out specific studies of peat production machines and equipments and to follow up total production systems in order to gradually develop the knowledge of methods, systems and machines in practical energy peat production. The project has been divided into three sub-activities: 1 Comparative time and production studies of single peat production machines and equipments, 2 Monitoring of complete systems for peat production, 3 Technical testing and evaluation of production machines and equipments. (author).

37335 (CONF-8509275—, pp 287-292) **Vyrmethane method, in situ gasification of peat/drainage of peat bog with help of mathematical models.** Martinell, R.; Tannenberg, D. (Vyrenergi AB, Taeby, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

This paper describes how the Vyrmethane process works. Water is pumped out of the peat bog. Then the methane in the water is separated. This can, for example, be done by exposing the water to reduced pressure. When the degassed water is then infiltrated in the bog, certain bacteria are stimulated to start a process leading to new methane being formed and dissolved in the water. Then the water is pumped up again. In this way the bog is pumped of its energy contents without having to dig it up. To pump water around demands a contribution of energy. The amont of electricity needed to recover the methane is decisive for the economy of the process. It is possible to get 5 kWh methane heat per input kWh of electricity. This is acceptable. Theoretically there are possibilities to improve this relation considerably. There are now, also, practical indications that this could be possible. The critics of the method had questioned whether the method could work during the winter. As mentioned above it turned out to function even better during the winter. The experiments verified that the process worked and also gave a lot of material support for the continued work which is now ready for full scale. Vyrenergi AB has worked out data models for drainage purposes. The purpose of these models is to get an optimum drainage system both as regards the quite physical work and the optimum from the economic point of view, i.e. to be able to make efficient use of the bog for methane recovery as quickly as possible.

37336 (CONF-8509275—, pp 365-370) **Influence of meterological and soil and nature factors on intensity of milling over of peat deposits.** Malkov, L.M. 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

The process of surplus moisture removal by the warmth of the sun and surrounding air is considered. Water evaporation intensity from peat was determined with respect to a number of meteorological factors and the influence of precipitations on duration of breaks in the technologic extracting process. The influence of soil and nature factors on peat drying process was demonstrated. The preceived dependences permit calcuation of peat deposit layer, milled over during a year, depending on climatic and geomorphological conditions of peat deposit bedding, and also to determine the main technological indicators of peat extraction. In our case the meteorological factors are characterized by the quantity of water evaporation from standard water-saturated material. In the report equations are given for calculating the components of the evaporator's heat balance. There are given connections between evaporation from the water surface and from the peat layer (particle) of different qualitative characteristic. The methodics are described for the amount of evaporated water during the season, subject to variability of weather conditions during years. From water balance equation, the thickness of milling over peat layer during the year is being determined. Comparing the results of heat and water balance calculations one can determine the possible intensity of peat deposit milling over. Practical recommendations are given for the choice of peat winning programme. (author).

37337 (MSHA/IR—1143) **Injury experience in coal mining, 1982.** (Mine Safety and Health Administration, Denver, CO (USA). Health and Safety Analysis Center). 1984. 314p. NTIS, PC A14/MF A01. File Number DE86901492.

This Mine Safety and Health Administration (MSHA) informational report reviews in detail the occupational injury and illness experience of coal mining in the United States for 1982. Data reported by operators of mining establishments concerning work injuries are summarized by work location, accident classification, part of body injured, nature of injury, occupation, and anthracite or bituminous coal. Related information on employment, worktime, and operating activity also is presented. For ease of comparison between coal mining and the metal and nonmetal mineral mining industries, summary reference tabulations are included at the end of the report. Data used in compiling this report were reported by operators of coal mines and preparation plants on a mandatory basis as required under the Federal Mine Safety and Health Act of 1977, Public Law 91-173 as amended by Public Law 95-164. Since January 1, 1978, operators of mines or preparation plants or both which are subject to the Act have been required under 30 CFR, Part 50 to submit reports of injuries, occupational illnesses, and related data. Only data reported by the operators themselves are utilized in this report. 23 tabs.

37338 (MSHA/IR—1150) **Laboratory evaluation of a commercially available underground dry dust collection system.** Parobeck, P.S.; Gadomski, R.R.; Atchison, D.J. (Mine Safety and Health Administration, Arlington, VA (USA)). 1984. 10p. NTIS, PC A02/MF A01. File Number DE86901510.

This paper describes a laboratory evaluation conducted to determine the dust collection efficiency of an auxiliary blower fan with integral dry dust collector designed and built by BAMCO of West Virginia, Inc., and B and J Manufacturing Company of Glenwood, IL. The unit is designed for both pneumatic tire and rail maneuverability. The auxiliary fan is capable of moving approximately 10 to 15 thousand cubic feet of air per minute through a five-stage dust removal section. Dust collection efficiency of the unit was determined by passing minus 200 mesh coal dust at concentrations ranging from 50 to 280 mg/m^3 through the unit. Sampling conducted both up and downstream of the unit showed that the unit is approximately 99 percent efficient for particles greater than 3.0 micrometers in size and has an efficiency of greater than 96 percent for particles down to one micrometer. 4 refs., 5 figs., 3 tbls.

37339 (MSHA/IR—1151) **Respirable dust control on longwall mining operations in the United States.** Mundell, R.L.; Jankowski, R.A.; Ondrey, R.S.; Tomb, T.F. (Mine Safety and Health Administration, Arlington, VA (USA)). 1984. 26p. NTIS, PC A03/MF A01. File Number DE86901501.

Between 1967 and 1978 use of longwall methods to mine coal in the United States continually increased. Although these methods offer several advantages, health hazards often exist because of unique and difficult problems in the control of respirable dust. This paper discusses the results of respirable dust studies conducted on United States longwall mining operations in 1972 and 1978. Prevalent engineering control methods (ventilation, water application and use of machine cutting parameters) and administrative controls for minimizing employees' respirable dust exposure are discussed. Current research efforts for the control of respirable dust on longwall mining operations are reviewed. 21 figs.

37340 (MSHA/IR—1152) **MSHA's procedure for determining quartz content of respirable coal mine dust.** Goldberg, S.A.; Tomb, T.F.; Kacsmar, P.M.; Baber, J.J. Jr.; Busa, M.J. (Mine Safety and Health Administration, Pittsburgh, PA (USA). Pittsburgh Health Technology Center). 1984. 15p. NTIS, PC A02/MF A01. File Number DE86901500.

In accordance with Section 205 of the 1969 Federal Coal Mine Safety and Health Act, the Mine Safety and Health Administration instituted a program to establish the applicable respirable dust standard when the quartz content of respirable dust in the mine atmosphere was more than 5 percent. The analytical method originally used to determine the amount of quartz in the mine atmosphere required 1 to 4 milligrams of respirable dust before a quartz determination could be made. Because samples collected during a coal mine health inspection often contained less than the amount required for a quartz analysis, the number of coal mines with quartz determinations was limited. Therefore, in 1981 the analytical method was modified, permitting a quartz determination to be made on a sample containing as little as 0.5 mg of respirable coal mine dust. This paper discusses the modifications made to the analytical procedure and the experimental work conducted to demonstrate that the analytical results obtained with the modified method are equivalent to those obtained with the original method. 10 refs., 13 figs., 3 tabs.

37341 **(MSHA/IR—1153) Field evaluation of the SIMSLIN II light-scattering instantaneous dust monitor.** Gero, A.J.; Beckert, A.J.; Jankowski, R.A.; Tomb, T.F. (Mine Safety and Health Administration, Arlington, VA (USA)). 1984. 12p. NTIS, PC A02/MF A01. File Number DE86901516.

This paper presents and discusses the results of measurements made in underground coal mines with the SIMSLIN II respirable dust monitor. The SIMSLIN II is an instantaneous-reading dust monitor employing the principle of light-scattering to measure the mass concentration of respirable dust. The instrument was designed and developed by the Safety in Mines Research Establishment in the United Kingdom. During this evaluation, full-shift gravimetric respirable mass measurements were compared with integrated signals obtained from the scattered-light detector. Comparative measurements were obtained on coal mine dust clouds varying in particle size distribution, composition, and concentration to evaluate their effects on instrument calibration. In addition, tests were conducted to evaluate the instrument's potential use as a machine-mounted respirable dust monitor capable of providing real-time information to a continuous mining machine operator. 13 refs., 10 figs.

37342 **(PB—86-183472/XAB) Highwall elimination and return to approximate original contour as required in the Surface Mining Control and Reclamation Act of 1977. Final report.** (National Research Council, Washington, DC (USA)). Mar 1984. 215p. NTIS, PC A10/MF A01.

The report covers the following issues concerning: highwall elimination, reclamation, and approximate original contour in surface-mining applications.

37343 **(PB—86-189008/XAB) Investigation and control of noise generated during coal cutting. Open File report, September 1978-August 1985.** Pettitt, M.R. (Wyle Labs., Huntsville, AL (USA)). Aug 1985. 138p. (REPT—63251-01-WR23). NTIS, PC A07/MF A01.

The report presents the results of an extensive research and development program to reduce the noise generated during coal cutting. The characteristics and magnitude of continuous miner coal-cutting noise sources are defined. This work consisted of development of a simulated coal seam to facilitate above-ground coal cutting tests, noise measurements in a reverberant acoustic chamber during simulated mining operations of a continuous miner (cutting the simulated coal seam), and noise measurements in an underground coal mine during continuous miner operation. Methods to reduce coal cutting noise are presented. These methods take full advantage of the dynamic characteristics of the forces generated during coal cutting. Dynamic cutting force isolation was shown to be a very effective technique.

37344 **(PB—86-195864/XAB) Delayed-blasting tests to improve highwall stability - a final report. Report of Investigations/1986.** Stachura, V.J.; Fletcher, L.R.; Peltier, M.A. (Bureau of Mines, Twin Cities, MN (USA). Twin Cities Research Center). 1986. 19p. (BM-IC—9008). NTIS, PC A02/MF A01.

The Bureau of Mines conducted a series of delayed-blasting experiments at a Barbour County, WV, contour coal mine that resulted in smoother highwalls. The highwalls were smoother due to reduced overbreak (excessive rock breakage beyond the excavation limit) and were inherently safer due to reduced likelihood of rockfall. The experiments were directed at reducing overbreak without special drilling or significant additional cost. Reduced overbreak was accomplished by increasing the highwall hole delays, which changed the effective delay-pattern geometry and the direction of burden movement.

37345 **(PB—86-196581/XAB) Short-delay blasting in underground coal mines. Information Circular/1986.** Mainiero, R.J.; Verakis, H.C. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center). 1986. 20p. (BM-IC—9064). NTIS, PC A02/MF A01.

The Bureau of Mines has conducted research to determine whether the total elapsed delay time for blasting bituminous coal in underground mines could be safely expanded beyond the present 500-ms limitation without igniting a methane or methane-coal dust atmosphere. The results indicated that the increase of total delay from 500 to 1,000 ms had no detectable effect on safety relative to incendivity as long as permissible practices were observed in all other aspects. Research was also conducted to evaluate the safety of 18-in hole spacing for delay blasting in coal relative to misfires.

37346 **(VTT-TIED—505) Safe production and use of domestic fuels, part 2. Fire detectors.** Linna, V. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). Oct 1985. 61p. (In Finnish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752302.

Fire detectors and their suitability to peat boiler plants is considered. The main interest is concentrated on the methods applicable to detection of smouldering fires. The description of fire detection methods is based on the literature and brochure information of the devices. In addition fire detection and extinguishing systems of three peat boiler plants are described briefly. The conventional smoke detectors are not applicable to detection of smouldering fires in dusty environments. IR spark and flame detectors have been developed intensively during the last years and these are also available to detection of smouldering fires. The improvement of detectors has decreased their sensitivity to false alarms. The present IR detectors are most applicable to spark and fire warning in pneumatic dust coveyor tubes and in dust separators, but these detectors have been used also in association with belt conveyors at peat heating plants.

0130 Transport And Handling

REFER ALSO TO CITATION(S) 37291, 37292, 37299, 37334, 37373

37347 (CONF-8509275—, pp 227-231) **Self-heating and self-ignition of peat during storage.** Lishtvan, I.I.; Gavrilchik, A.P.; Falyushin, P.L. (Inst. of Peat of the BSSR Academy of Sciences, Minsk, Byelorussian SSR). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Self-heating of peat during storage leads to considerable changes in physico-chemical properties which result in pollution of the environment by thermal destruction products and increased content of fine dust fraction. Considerable losses in product quality and quantity occur due to self-heating and self-ignition. Self-heating takes place as the result of microbial and physico-chemical processes conditioned by geobotanical characteristics, chemical composition and physico-technical properties. Chemical composition of organic and mineral components determines the potential tendencies; technological factors determine actual behaviour of peat. Role of drying conditions in changing the reactivity of peat is shown, and principal factors activating the autothermal processes are determined. Relationship between organic substance losses and heating temperature, aeration conditions and storage duration is demonstrated; methods for their determination is given. Exothermal processes are found to become more intensive with the increase of internal heat- and mass-transfer. It is shown that redox hydrolytic and ion-exchange processes, in the result of which organo-mineral and mineral components are converted into pyrophoric substances causing self-ignition, take place during self-heating of peat. Salts of carboxylic acids are formed during intensive auto-oxidation. Relationship between iron content and inclination of self-heated peat for self-ignition during storage is determined. Method for prognostication of peat inclination to self-ignition is developed. New technological schemes of storage which prevent intensive self-heating, avert self-ignition and decrease pollution of the environment are suggested.

37348 (CONF-8509275—, pp 233-241) **Prevention of fires and dust explosions at peat fired power plants.** Mutanen, K. (Technical Research Centre of Finland, Jyvaeskylae, Finland. Domestic Fuel Lab.). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

This paper presents results and conclusions of research and development work which has been carried out by the Technical Research Centre of Finland (VTT) in loss prevention at peat utilization plants. The project 'Safe utilization of indigenous fuels' started in April 1984 and will continue until March 1987. Dust explosions at milled or sod peat fired plants may lead to serious accidents. Although the safety of peat utlization in Finland has improved significantly, the formation of peat dust causes unexpected risks. The diversity and size of heat and power plants prevents a systematic improvement of safety. The prevention of losses at peat fired plants includes the developement of fire detection and fire-fighting equipment as well as prevention of peat dust and sources of ignition. Plant layout and materials used are selected so that, in the case of an explosion, damage will be kept to a minimum. Explosion venting has to be used especially in silos and conveyors. Accurate safety instructions are needed for the planning of new plants. Models for safety and operating instructions and risk analysis will facilitate the planning of codes and rules. Training of power plant operators in the use of fire-fighting equipment and how to behave in areas of hazards is essential. However, where humans are involved, errors must be expected. In most cases, large losses occur due to human errors in not carrying out their functions properly. This is the reason why it is essential to try to minimize the risk of human error, too. With 2 refs.

37349 (CONF-8509275—, pp 355-364) **Fire prevention and control in connection with production and handling of peat.** Michal, O. (Swedish Board of Rescue and Fire Services, Stockholm, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Peat in the form of a fine, dry dust has on several occasions been known to give rise to dust explosions during post-production handling and storage, e.g. during transport and in silos. In addition to fires caused by external sources (machines, tools, smoking, etc.), peat is also liable to ignite spontaneously (by microbiological processes). Particular attention should be paid to this hazard in stacking peat at the site of production. A peatland fire can burn for months. Extinguishing such fires requires considerable resources in terms of water, fire-fighting equipment and - which is just as important - personnel. The local fire chief should therefore be contacted at the planning stage of peat extraction operations. The following points be borne in mind in planning for peat extaction: - the danger of the fire spreading inside and beyond the bounds of the site, provision of fire lines, - road network, turning points for vehicles, accessibiility, - workplace and central depots, - provision of water points, location and capacity. This will depend on the size of the site, - fire-fighting equipment depending on the site, - alarm and coordination on the site itself and with the emergency centre, - own fire-fighting organization, - adaptation of machines and their fire-fighting equipment, - on-site regulations, - storage of cut peat, - actions plan and fire-fighting map. With 2 refs. (author).

37360 (CONF-8509275—, pp 401-422) **Problems of artificial peat dewatering.** Korchunov, S.S. 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Dewatering opens the perspective of all-year round industry not depending on unfavourable weather conditions. At present work on dewatering is being carried out by different methods. Water can be removed by drawing off moisture or with the application of external pressure. The latter way is more power-intensive but has wide possibilities. Theoretical work shows that the real efficiency of the mechanical release process is not large and is of the order of 1 - 10%. The effect of pressing can be calculated if we have filtration and compression characteristics. It should be pointed out that these characteristics depend on moisture content to a great extent and that is the factor limiting the process of effective peat dewatering. The main obstacles of the development of the dewatering process are: acute decrease of filtration ratio with packing, peat extrusion in pressing, serviceability of filtration surfaces and the difficulty of the removal of the thin peat layer from the filters. The most investigated method is the mechanical water release in presses. In industrial presses the pressure reaches 100 x 10^5 pa. Among the most developed equipment there can be noted the horizontal many-layered press of periodical action, press for thermal insulation boards and substrate blocks, band-roll and band-ring press of continous action. With a one-step mechanical release we can get peat with moisture content 75-77%, with a two-step process about 65-70%. Less wide spread methods are vacuum processing, gravitational drying, centrifuging, contact suction, electroosmosis, pressing of frozen peat. To accelerate the pressing process, the effect of coagulation and additives of chemical agents, thermochemical processing, freezing, peat draining, many step methods, vibrational effects, decrease of initial moisture content and the height of the dehydrated peat layer were controlled. With 20 refs. (author).

37361 (CONF-8509275—, pp 423) **Treatability studies on two thermal peat dewatering schemes.** Day, J.; Locci, A.; Sheppard, J.; Guilcher, M. (Environmental Protection Service Environment Canada, Dartmouth, Nova Scotia, Canada. Water Pollution Control Div.). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Effluents from two prcesses designed to thermally pretreat fuel grade peat to enhance its dewaterability were considered in this study, pressate from the WETOXsup(R) process reactor at the Ontario Research Foundation and from the wet carbonization reactor at the Institute of Gas Technology in Chicago. The study was undertaken to assess anaerobic treatability of the peat pressate using bench scale models of a high rate NRC downflow filter and an ADI - Bulk Volume Fermentor (ADI-BVF). An aerobic model was operated on the BVF effluent to assess its impact on BOD and ammonia removals. Performance was assessed as organic loadings were increased. Results indicate that the pressates are amenable to anaerobic treatment; the biogas produced would be an excellent addition to dry peat derived fuel; after full maturation of the anaerobic system no nutrient addition should be required; the effluent is toxic to fish, however aerobic polishing of the effluent from the anaerobic reactor further reduces organic loadings and the toxicity. (author).

37362 (DOE/ER/13244—T1) **Report on DOE coal contract.** Jacobs, I.S. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Center). 30 Sep 1985. Contract FG02-84ER13244. 21p. NTIS, PC A02/MF A01. File Number DE86008583.

Micrographs and quantitative (relative) chemical scans are shown for 7 particles from the sample of MIT-(microwave and ignited)-treated coal designated 841206, No. 1A.1 and No. 1A.3. Magnetic measurements had shown this treated coal to be rather strongly magnetic. The Mossbauer spectrum No. 2036 reported in March 1985 showed some Fe_3O_4, some Troilite/disordered Pyrrhotite, a little Fe metal, a lot of pyrite and some Fe^{2+} in something which is close to the Fe in Illite clay position (for whole coal) but displaced slightly. The quantitative scans shown are for sulfur (S) and iron (Fe). The responses include the respective noise backgrounds, and the count yields are different for the two elements. Therefore it is risky to attribute meaning to the continuation of sulfur counts well beyond the particle edge. Such counts are a combination of background noise plus any real sulfur in the coal.

37363 (DOE/FE—0063) **Final report on US - Italian coal logistics.** (USDOE Assistant Secretary for Fossil Energy, Washington, DC; Ministero dell'Industria, Commercio e Artigianato, Rome (Italy)). May 1986. 249p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE86012639.

The main purpose of the study has been to determine the level of significance of various factors on the overall coal trade infrastructure between the two countries: quantities, types, and sources of US coal; current and projected Italian coal requirements; US transportation and port infrastructure capabilities to transport coal to export ports and load ocean-going vessels; ocean transport infrastructures; and Italian port and transportation infrastructure capabilities to receive coal imports and transport them to points of industrial utilization. A coal purchaser who contracts for US rail transportation can likely achieve lower short-term rates, have greater certainty as to costs over the longer term, and be less vulnerable to unpredictable rate changes than one who depends solely on tariff rates. Another economic factor is the increasing importance of wa-

terway transport, which has declined due to greater productivity arising from the increased use of more powerful and efficient towboats and larger barges. Barge companies typically operate under long-term contracting arrangements, with rates historically 20% lower than rail rates. Additional savings of as much as 50% can be obtained by the direct off-loading barges at the terminal and subsequently loading colliers from the terminal. Using Panamax-sized vessels (50,000 to 80,000 dead weight tons, DWT), the East Coast ports of the United States handle over 50% of the country's exports. The vessel size is a direct reflection of the draft and beam limitations of the principal ports of Newport News, Baltimore, Mobile, and New Orleans. Currently, there are no substantial savings to be gained by using larger ships, since Italian ports (except Taranto) also have draft and beam limitations. Innovative vessel designs, more sophisticated loading and unloading systems, increased competition among ports' services, and competitive chartering for coal have also added to savings. 31 figs., 38 tabs.

37354 **(DOE/FE/60181—179) Dewatering dilute fine coal/water slurries to produce coal/water fuel.** Maas, D.J.; Sears, R.E.; Potas, T.A. (North Dakota Univ., Grand Forks (USA). Energy Research Center). Apr 1986. Contract FC21-83FE60181. 11p. (CONF-860855—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010105.

From 5. international drying symposium (IDS '86); Cambridge, MA, USA (13 Aug 1986).

Vendor assisted concentration studies were conducted on hydrothermally treated low-rank coal water (LRCW) slurries using a hydroclone, centrifuge, plate and frame filter, belt pressure filter, electrofiltration techniques and electroacoustic dewatering. The release of inorganic constituents into the process water, release of tar, and reduction of coal particle size due to pilot-scale hydrothermal processing all contributed to the difficulty in separating the process water from the solid products. The centrifuge was determined to be the best commercially available method. After purchasing a centrifuge, optimization studies were conducted to determine the best operating conditions for concentrating hydrothermally treated LRCW slurries. 6 refs., 8 figs., 4 tabs.

37355 **(DOE/MC/20122—2082) Physical beneficiation process and costs refinement for coal-water slurry manufacture. Final technical report, September 1984-December 1985.** Looney, J.H.; Im, C.J. (UCC Research Corp., Bristol, VA (USA)). Jun 1986. Contract AC21-83MC20122. 173p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86012686.

Under the sponsorship of DOE/METC, UCC Research completed a program in 1984 concerned with the development, testing, and manufacture of an ultra-clean coal-water mixture fuel using the UCC two-stage physical beneficiation and coal-water mixture preparation process. Several gallons of ultra-clean coal-water slurry produced at the UCC Research pilot facility was supplied to DOE/METC for combustion testing. The finalization of this project resulted in the presentation of a conceptual design and economic analysis of an ultra-clean coal-water mixture processing facility sufficient in size to continuously supply fuel to a 100 MW turbine power generation system. Upon completion of the above program, it became evident that substantial technological and economic improvement could be realized through further laboratory and engineering investigation of the UCC two-stage physical beneficiation process. Therefore, as an extension to the previous work, the purpose of the present program was to define the relationship between the controlling technical parameters as related to coal-water slurry quality and product price, and to determine the areas of improvement in the existing flow-scheme, associated cost savings, and the overall effect of these savings on final coal-water slurry price. Contents of this report include: (1) introduction; (2) process refinement (improvement of coal beneficiation process, different source coals and related cleanability, dispersants and other additives); (3) coal beneficiation and cost parametrics summary; (4) revised conceptual design and economic analysis; (5) operating and capital cost reduction; (6) conclusion; and (7) appendices. 24 figs., 12 tabs.

37356 **(EPRI-CS—4434) Coal cleaning test facility campaign report No. 4: Kentucky No. 11 seam coal.** Hervol, J.D. (Kaiser (Raymond) Engineers, Inc., Homer City, PA (USA); Science Applications International Corp., Homer City, PA (USA)). Jun 1986. 151p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920353.

The cleanability characteristics of Kentucky No. 11 Seam coal are the subject of Campaign Report No. 4 issued by EPRI's Cleaning Test Facility (CCTF). In July 1983, the CCTF cleaned Kentucky No. 11 Seam coal in three different flowsheets with the goal of reducing potential sulfur dioxide (SO_2) emissions. Test results show that coal cleaning is able to lower potential SO_2 emissions by about 50 percent (from nearly 10 lb/MBtu in the raw coal to about 5 lb/MBtu in the clean coal) with energy recoveries greater than 80 percent. Boiler ash loadings, on a lb/MBtu basis, are also significantly reduced - a 90 percent or greater reduction can be achieved with coal cleaning. Based on empirical indices, coal cleaning does not significantly affect the slagging and fouling potential of Kentucky No. 11 Seam coal. However, the Tennessee Valley Authority which was burning Kentucky No. 11 Seam coal raw was having severe slagging and fouling problems, causing a significant derating at its Cumberland Power Station. When TVA began burning a blend of cleaned Kentucky No. 11 Seam and Kentucky No. 9 Seam coals, they saw improvements in terms of slagging and fouling, resulting in a recovery of most of the derated capacity. 11 refs., 24 figs., 24 tabs.

37357 **(KTM/E—8421) Constructional solutions of fuel handling equipment needed in heating plants using domestic fuel.** Lahdenperae, T.; Marjosalmi, J.; Kirjavainen, R.; Vaeisaenen, O. (Ministry of Trade and Industry, Helsinki (Finland). Energy Dept.). Dec 1985. 110p. (In Finnish). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752116.

Constructional solutions of fuel handling equipment needed in heating plants using domestic fuel depend on several factors such as heating capasity of the plant, fuel, type of boiler and availble space. On the basis of the field study and other studies the sizes of type solutions were chosen to be 10-30 kW, 30-100 kW, 100-300 kW and 300-1000 kW. Because automation of fuel handling is often a qualification for more extensive use, peat pellets, sod peat and chips are considered the most suitable for that. As for boiler types, such boilers were examined in which fuel is fed from above and from the side to the furnace. As for space solutions, such cases were included in the examination in which the fuel supply was on the same level with the boiler room or above the boiler room. On the basis of these factors the study presents nine various type solutions, each of which contains a description of fuel handling equipment and ash removal equipment, main dimensioned drawings of equipment and their cost estimation. The costs of equipment range from FIM 10,000 to FIM 37,000. The study includes instruction for applying type solutions in practise as well as for automatization of activity. In the end the study includes also matters concerning fire safety.

37358 **(PB—86-184660/XAB) Report on potential for cost reductions in inland transportation of US coal exports. Final report.** (International Trade Administration, Washington, DC (USA). Office of Energy). Aug 1983. 125p. (ITA/OE—86/03). NTIS, PC A06/MF A01.

This report which examines the current status of inland coal-transportation costs. It reviews each of the major transportation modes in the coal-export chain, including rail, barge, port-facility, and coal-slurry-pipeline systems as well as the linkages among these transport modes.

37359 **(STEV-TORV—86-8) Back pressure drying of solid, moist fuels.** Hilmart, S.; Muenther, M. (Statens Energiverk, Stockholm (Sweden)). Dec 1985. 97p. (In Swedish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752278.

Many specific results concerning the characterization of wood fuels and their treatment including back pressure drying are presented. Combustion of biomass fuels and the technique and

economy of reprocessing of peat are treated. An experimental installation for back pressure drying is described. (G.B.).

37360 **(STEV-TORV—86-11) Importance of maceration for the sod peat quality.** Anttila, R.; Olsson, R. (Statens Energiverk, Stockholm (Sweden)). Feb 1986. 43p. (In Swedish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752487.

The aim of the project was to investigate the importance of the degree of maceration for the peat quality and compare machine constructions with sod peat machines referring to energy input and peat quality. The results have been obtained by literature studies, mapping of present situation of the technology, and by laboratory experiments with peat mill and Werner-Pfleiderer mill. By increased degree of maceration a fine distribution of the coarse fibres is obtained, as well as increased volume weight and shrinkage and increased resistance against rewetting. By increased energy input increased degree of maceration is obtained, which gives better peat quality but reduced capacity. The peat quality is improved with increased degree of maceration up to a certain level, without appreciable changing anymore even if the maceration is continued. The results show that the energy input in the maceration experiments with peat mill is comparative with the energy input for maceration in modern tractor-pulled sod peat machines, while the peat quality becomes considerably better in maceration in peat mill. Comparison with sod peat machines referring to capacity and energy input cannot be carried out with obtained results, as the presented experiments have been carried out in laboratory scale. For comparative studies experiments must be performed in industrial scale, which is planned to be carried out in the following phase. In summing up it can be asserted that with the same energy input that is used for maceration in sod peat machines the peat quality can be improved considerably, with suitable machine construction. The maceration part should be optimized referring to energy input, capacity and peat quality, not least if the peat quality is going to be valued as payment basis factor in the future besides the quantity.

37361 **(STEV-TORV—86-13) Investigation concerning spreading area, turning and the quality of the drying surface for drying course and production of sod peat.** Eriksson, E.; Sandstroem, T.; Anttila, R.; Olsson, R. (Statens Energiverk, Stockholm (Sweden)). Feb 1986. 28p. (In Swedish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752488.

By order of Swedish Peat Research Foundation, LKAB and National Swedish Laboratory for Agricultural Chemistry (SLL) have carried out the project on Kiruna Grus and Stenfoeraedlings peat winning area Kauppisenvouma, Kiruna and Umeaa Energiverks peat winning area Traeskmyran, Umeaa. The aim of the project was to investigate the importance of different amount of sod peat per square meter (sq.m.) spreading area, turning and the quality of the drying surface for drying and production. The amount of sod peat per sq.m. spreading area influences on the drying course so that the exposure surface against solar and wind varies. In the SLL-study some faster drying course was obtained with less amount of sod peat per sq.m. spreading area. In the LKAB-study it is more difficult to draw univocal conclusions, because of abundant precipitations and small changes in the moisture content. The positive influence of turning for the drying course can be verified in both studies. The SLL-study proves also that the drying is continued with undiminished speed after windrowing. Influence of the quality of the drying surface is difficult to estimate. The SLL-study proves that under favourable conditions it seems that the quality of the drying surface has not any influence on the drying speed. It is however difficult to decide the real quality of the drying surface, because the production machine takes up the surface more or less. Under worse conditions it is possible that much milled peat on the surface has a negative influence on the drying course. In the LKAB-study it is more difficult to see some differences referring to earlier presented meteorological reasons, but referring to production experiences the drying course is fastened with the drying surface free from milled peat.

37362 **(TKK-KO/ET—7) Application of fluidization technology to steam drying of milled peat.** Huhtinen, M.; Hulkkonen, S.; Jahkola, A. (Helsinki Univ. of Technology, Otaniemi (Finland). Inst. of Energy Engineering). Oct 1985. 247p. (In Finnish). NTIS (US Sales Only), PC A11/MF A01. File Number DE86752112.

The study is concentrated on examining fluid bed drying of milled peat using superheated water vapour as fluidizing medium. For design and dimensioning of fluid bed steam dryer the theoretic foundations concerning hydrodynamics, heat transfer and drying rate of particles in steam fluidized are presented. The dry bed material used in fluidized beds is usually same as the material to be dryed. The use of separate bed material offers, however, a possibility to decrease investment and operational costs of the fluid bed dryer. The most important bed material properties affecting heat transfer and hydrodynamics in fluidized bed are particle size and density. A pilot fluidized bed dryer for researching steam drying of milled peat has been built during this project. The use of steam as drying medium makes it possible to decrease energy consumption compared to traditional drying methods. The integration of fluidized bed steam dryer to district heating power plant has been examined as an example. At district heating power plant the dryer is heated indirectly with extraction steam from the turbine and the condensate can be recirculated into the feed water tank. When the water vapour generated in dryer is condensed in an additional district heating heat exchanger, almost all energy used to drying can be recovered. Compared with the flue-gas flash-dryer, commonly used in drying of milled peat, the fluid bed steam dryer with milled peat as bed material was found out to be much more economical.

0140 Combustion

REFER ALSO TO CITATION(S) 37305, 37308, 37333, 37346, 37356, 38195, 38806, 38807

37363 **(CONF-860805—5) Combustion of pulverized coal in various atmospheres.** Chang, K.C.; Berry, G.F.; Wang, C.S.; Wolsky, A.M.; Choi, U.S. (Argonne National Lab., IL (USA)). Nov 1985. Contract W-31-109-ENG-38. 55p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86005516.

From International heat transfer conference; San Francisco, CA, USA (17 Aug 1986).

In this modeling study, a one-dimensional coal combustion or gasification (1-DICOG) computer code was used to simulate differences in the combustion performance of pulverized coal resulting from the substitution of various CO_2/O_2 mixtures for air in the combustion atmosphere. Predictions using this simple, one-dimensional model were compared with actual performance data from tests conducted by Battelle Columbus Laboratories. The resulting comparisons of predicted and measured data for all test cases show that the observed trends of distributions of temperature and of species concentrations are predictable; discrepancies between predictions and measurements of these data are attributed to limitations of the 1-DICOG computer code. The study finds that the combustion processes of pulverized coal can be completed in an atmosphere of CO_2 and O_2 over a range of CO_2-to-O_2 mole ratios between 2.23 and 3.65. 8 refs., 18 figs., 2 tabs.

37364 (CONF-8509275—, pp 185-199) **Formation of emissions from combustion of wood and peat at district heating plants.** Vesterinen, R.; Huotari, J. (Technical Research Centre of Finland, Jyvaeskylae, Finland. Domestic Fuel Lab.). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Research on emissions and combustion processes has been carried out at district heating plants. An attempt has been made to explain indirect factors affecting the formation of emissions by changing the moisture content of fuels and the loading level of the plant. Emissions of carbon monoxide, carbon dioxide, nitrogen oxides, total hydrocarbon and sulphur dioxide from plants have been continuously measured. In addition emissions of fly ash and polycyclic aromatic hydrocarbons have been measured by serial measurements. During the measurements the properties of fuels and

the combustion process have been controlled. Continous control of the dust content of flue gas has been done at some plants. The dependencies of emission components on process conditions and combustion equipment have been explained by using the results of the research discussed above.

37365 (CONF-8509275—, pp 201-208) **Peat combustion - environmental effects and emission limits.** Timm, B. (National Swedish Environmental Protection Board, Solna, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

A main goal of the Swedish energy policy is to substitute oil with other, mainly domestic, fuels with the least possible environmental effects. To promote this, government financial support has been directed towards new combustion plants for solid fuels. A general prerequisite for obtaining financial support is that the use of new fuels or techniques will result in a reduction of negative environmental effects. The line followed is a close cooperation between research aiming at new combustion and cleaning techniques and the administrative authorities that set emission standards and issue other regulations and recommendations. Energy conversion processes can give rise to environmental problems by - emissions to the air and water, - environmental disturbances from the transportation, handling and storing of the fuel and ashes, - restrictions on the future land use, and - effect on the landscape. The issues dealt with here will mainly concern emissions of air pollutants and the disposal and utilization of ashes from the combustion of peat. Some references will be made to other fuels. (author).

37366 (CONF-8509275—, pp 331-342) **Emissions from peat burning.** Pohjola, V.; Haesaenen, E. (Technical Research Centre of Finland, Espoo, Finland). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

In 1983 Finland used 10.3 million m^3 peat (about 740000 toe) for energy production. It has been estimated that the use of peat will almost triple by 1995, reaching about 27 mill. m^3. The burning of peat generates gaseous and particle pollutants into the atmosphere. The emissions caused by peat burning have been thoroughly studied at the Technical Research Centre of Finland. The aim was to investigate the emissions of peat-fired power plants and to compare the emissions to the emissions from power plants using other fossil fuels. Emission of the following components were measured: sulfur dioxide, nitrogen oxides, carbon monoxide and dioxide, total hydrocarbon, PAH-compounds, aldehydes, particulates, heavy metals (e.g. lead, cadmium, beryllium, mercury, vanadium, nickel, zinc), and radioactive elements (e.g. uranium, torium). Emission factors expressed per fuel energy for selected components interesting from the environmental point of view are presented. With 2 tables, 5 figures and 2 refs. (Author).

37367 (DOE/FE/60181—182) **Single-particle combustion of Beulah lignite char.** Young, B.C.; McCollor, D.P.; Weber, B.J. (North Dakota Univ., Grand Forks (USA). Energy Research Center). 1986. Contract FC21-83FE60181. 31p. (CONF-860804—3). NTIS, PC A03/MF A01; GPO Dep. File Number DE86006127.

From 21. international symposium on combustion; Munich, F.R. Germany (3 Aug 1986).

A novel single-particle flameless reactor has been designed and constructed for investigating the combustion behavior of individual coal particles, incorporating a three-color optical pyrometer for measuring single-particle temperatures. Results for the combustion of Beulah (North Dakota) lignite char at sizes below 200 μm and at gas temperatures between 760 and 1040K are presented. It was found that the particle temperature in all cases studied exceeded the local gas temperature by several hundred degrees. The burning rates were controlled by the mass diffusion of oxygen and mean particle temperatures and were found to be linearly dependent on oxygen mole fraction in the gas phase over the range of 0.05 to 0.16. The effects of particle size and oxygen concentration on particle temperature together with preliminary rate data are discussed. 20 refs., 6 figs., 2 tabs.

37368 (DOE/MC/19314—11) **Differential optical absorption techniques for diagnostics of fossil fuel combustion. Technical progress report, April-June 1985.** (Mississippi State Univ., Mississippi State (USA). MHD Energy Center). Mar 1986. Contract AC21-82MC19314. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012346.

The application of differential optical absorption (DOA) techniques for the in-situ determination of the chemical composition of fossil fuel combustion streams is investigated. Absorption spectra of relevant molecular species and the temperature and pressure effects on DOA-determined spectral characteristics of these species will be determined and catalogued. A system will be configured, assembled, and tested. An inexpensive, well characterized, strong source of OH emission was developed during this period. This task was accomplished by designing, building, and testing a microwave-powered electrodeless discharge lamp (EDL) using H_2O as the source for OH molecules.

37369 (DOE/MC/19314—12) **Differential optical absorption techniques for diagnostics of fossil fuel combustion. Technical progress report, July-September 1985.** (Mississippi State Univ., Mississippi State (USA). MHD Energy Center). Mar 1986. Contract AC21-82MC19314. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012347.

The application of differential optical absorption (DOA) techniques for the in-situ determination of the chemical composition of fossil fuel combustion streams is investigated. Absorption spectra of relevant molecular species and the temperature and pressure effects on DOA-determined spectral characteristics of these species will be determined and catalogued. A system will be configured, assembled, and tested.

37370 (DOE/METC—86/0236) **Atmospheric fluidized-bed combustion. Technology status report.** (USDOE Morgantown Energy Technology Center, WV). Oct 1984. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86001071.

The goal of DOE/METC's AFBC activities is to establish an engineering technology base by 1990, from which the industrial, commercial, and residential sectors can build and operate coal-fired AFBC systems. These systems will be capable of economically generating process steam, direct and indirect heat, and onsite electric power from coals of all ranks and sulfur contents in an environmentally acceptable manner. First-generation atmospheric fluidized-bed technology is considered commercial; a number of US boiler manufacturers are offering commercial units. However, many of these first units are products of empirical design and offer marginal gains in economics, performance, and reliability over conventional systems. In order to resolve the remaining technical issues and to broaden the market, DOE is pursuing advanced concepts. Development of this second-generation AFBC technology is directed toward small industrial, commercial, and residential applications. Penetration of these potential markets will require: (1) a 20 to 30% reduction in capital and operating costs over first-generation technology; (2) significant improvements in performance and reliability; and (3) compliance with existing and proposed New Source Performance Standards for environmental emissions. Current AFBC activities address: industrial operations, advanced concepts, and technology development. Four AFBC demonstration projects were active in FY 1984. The development of AFBC technology is directly supported by the evaluation of five advanced concepts by the M.W. Kellogg Company (circulating-bed FBC), Battelle Columbus Laboratories (spouted-bed FBC), Aerojet Energy Conversion Company (moving-bed FBC), Howard University (staged cascade FBC), and Arthur D. Little, Inc. (pulsed-bed FBC). These concepts may improve the economics and performance. 13 refs., 11 figs.

37371 (KTM/E-D—91) **Reliability and maintance costs of peat-fuel power plants.** Seppaelae, R.; Aeijaelae, M.; Koistinen, R.; Seppaenen, V. (Ministry of Trade and Industry, Helsinki (Finland). Energy Dept.). 1985. 77p. (In Finnish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752492.

In this study data was collected concerning faults and interruptions at peat-burning plants. Data collection was carried out by

means of forms sent to the plants. At the same time the plants were asked to supply service data, and the maintenance costs of peat equipment were also requested from the larger plants. The peat equipment, in other words the equipment which would not be found at equivalent oil-fired power plants, developed problems in a different way at the various plants. This report deals only with the most common ways in which problems developed for each equipment type. The effect on peat burning resulting from equipment problems depends on the location at the plant. For example, a fault in a conveyor downsream of the storage facilities stops the peat from reaching the boiler, whereas a fault in a conveyor upstream of the storage area only has an effect if it cannot be repaired before the storage bins are empty. An operational reliability model for one power plant was developed, with the aim of establishing the critical items of peat equipment. Average fault frequencies and repair times obtained for the equipment were used when designing the model. From the pint of view of operational reliability, the most important pieces of peat equipment after the burn-outgrate were the conveyors between the intermediate storage and the feeding silos.

37372 **(PB—86-184678/XAB) Coal Technology Reference Guide.** (International Trade Administration, Washington, DC (USA)). 1985. 106p. NTIS, PC A06/MF A01.

The purpose of the Coal Technology Reference Guide is to supplement A Basic Guide to Coal Exporting by providing information on the relationships between coal technology and coal quality. This Coal Technology Reference Guide describes the major types of coal-using technologies and the coal-quality requirements of each. The emphasis is on steam-coal technologies.

37373 **(SVF—197) Control of fuel-air ratio in pulverized fuel burners.** Gierse, M.; Sieurin, J. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Aug 1985. 85p. (In Swedish). (STUDSVIK-EB—85-4). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752149.

This report describes different methods for transport of pulverized coal to burners, direct methods as well as indirect systems are discussed. Results from measurements in pneumatic transport are presented and discussed. The main part of the report is a review of the possibility with different measurement principles to control and guide the combustion process and get an interaction between several burners. Better measurement techniques will lead to increase of burnout and even more important with new burner techniques it will give better control over NOsub(x)-emission.

37374 **(VTT-TIED—520) Comparison of peat and wood chips fired boiler plants and district heating systems.** Ranne, A.; Isomoettoenen, K. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). 1985. 110p. (In Finnish). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752306.

The operational ability of domestic fuel fired boiler plants in four district heating systems was studied. Then the structures and operations of the whole heat production system were analyzed. Finally, the influences of the heat delivery systems were compared with heat production costs. The combustion methods compared were ordinary grate combustion, grate combustion in insulated front furnace, circulating fluidized bed (CFB) and low heat value gas combustion (LHVG). The capacities of the boiler plants were 5-7 MW. The CFB- and LHVG-units were the first ones to be incoporated into district heating systems. In the efficiency measurements the best result, about 90%, was achieved in the boiler with mechanical grate, provided with digital control equipment. The best efficiences with other combustion methods varied from 87% to 88%. In the plant with ordinary grate combustion, 97% of the annual heat combustion was satisfied with domestic fuel. This is over 10%-units more than the average value of a good plant in respective condition. The results of the systems can be regarded as rather good.

37375 **(VTT-TUTK—381) Combustion tests of peat pellets by 20 kW test furnace.** Siimes, H. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). 1985. 96p. (In Finnish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752305.

The goal of this research was to study the combustion process affected by different factors related to combustion and combustion equipment. Such factors were moisture and the size of the pellets, excess air and the air distribution methods of the combustor. At the same time the methods in developing small combustion units were to be improved. The research was performed by examining theoretically the combustion phenomena of pellets and heat transfer in a sectionally cooled cylindrical test furnace. The influences of different parameters on the efficiency, the propagation of the combustion both in the fuel bed and in the gas above the bed and on the heat transfer in the furnace were studied experimentally. Pellets made from artificially dried milled peat were used as fuel. The increasing moisture content increased the need of combustion air resulting in decreasing combustion efficiency. Considering the combustion the optimal air coefficient was from 1.3 to 1.4. The greatest loss was caused by the sensible enthalpy of flue gas. The loss caused by combustible substances depended strongly on excess air.

37376 **Computed and experimental bubbles in a cold bed model of a fluidized-bed combustor.** Lyczkowski, R.W.; Bouillard, J.; Gidaspow, D. (Argonne National Lab., 9700 S. Cass Avenue, Argonne, IL). pp 781-782 of Proceedings of condensed papers of the 7th Miami international conference on alternative energy source. Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1986). (CONF-851201—).

From 7. Miami international conference on alternative energy sources; Miami Beach, FL, USA (9 Dec 1985).

The prediction of bubble and solids motion in fluidized-beds is important in understanding the stability and scale-up of fossil fuel gasifiers and combustors. Much experimental work over the last 30 years and more recent hydrodynamic computer modeling have studied the motion of bubbles, their formation frequency, and size. Solids motion studies are less common because of the experimental difficulties involved. Almost non-existent in the understanding of how bubbles interact with solid surfaces within fluidized-beds. These surfaces may take the form of instrument probes to detect the bubbles themselves and in the case of fluidized-bed combustors, heat exchanger tubes placed either in the bed or in the free-board or both. The purpose of this study is to investigate the interaction between bubbles and solid surfaces. A fluidized-bed is inherently oscillatory with no true steady-state ever achieved. Thus, hydrodynamic computer modeling is time dependent. It is also two dimensional. Computer generated motion pictures greatly facilitate the analysis of the computations since there are such a large number of complex phenomena which would be difficult or nearly impossible to comprehend in any other manner.

37377 **Investigation of diesel fuel injection equipment response to coal slurry fuels.** Phatak, R.G.; Gurney, M.D. (Southwest Res. Inst., San Antonio, TX). *American Society of Mechanical Engineers, [Paper];* No. 85-DGP-17, 1-7(Feb 1985). (CONF-850201—).

From ASME energy-sources technology conference and exhibition; Dallas, TX, USA (17 Feb 1985).

Availability and durability of fuel injection equipment are major problems in burning coal slurry fuels in fuel-injected type internal combustion engines. Initial testing with commercially available equipment indicated a very short life (approximately four minutes) due to plunger/needle scoring, heating, and lack of lubrication. Design changes to the equipment did not appreciably improve the equipment life. An air-assisted coal slurry injector, however, was designed and tested for over 100 hours of trouble-free operation with 40 percent coal plus DF-2 slurry fuel. The droplet size/size distribution study indicated much finer spray as compared with the solid injection system.

37378 **The combustion characteristics of coal slurry fuels in diesel engines: Detailed measurements and analysis.** Nelson, L.P.; Heap, M.T.; Sampson, T.W.; Seeker, W.R. (Energy and Environmental Research Corp., Irvine, CA). *American Society of Mechanical Engineers, [Paper];* No. 85-DGP-19, 1-8(Feb 1985). (CONF-850201—). Contract AC21-84MC21100.

From ASME energy-sources technology conference and exhibition; Dallas, TX, USA (17 Feb 1985).

A program designed to address the atomization, ignition, and combustion problems associated with the use of slurry fuels in

diesel engines is described. The program involves high-pressure injection rig and engine testing of three coal slurry fuels in Phase I, and modification of an existing analytical diesel engine heat release and pollutant formation model to include provision for coal slurry fuels in Phase II. The program approach and experimental facilities are discussed. The experimental testing portion of the program, which is currently in progress, is an extension of efforts conducted with three slurry fuels in a single-cylinder diesel research engine; the results of this previous program are described briefly.

37379 **Economic comparison of coal and wood for industrial steam generation.** Gaines, L.L. (Energy and Environmental Systems Division, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, IL). pp 1265-1285 of Energy from biomass and wastes IX. Chicago, IL; Institute of Gas Technology (1985). (CONF-850104—).

From 9. annual symposium on energy from biomass and wastes; Lake Buena Vista, FL, USA (28 Jan 1985).

The total costs of coal-generated and wood-generated steam from new industrial boilers are compared, and the dependence of these costs on plant size, capacity factor, and region is examined. Air pollution regulations are an important determinant of steam costs. Federal standards limit emissions from new boilers with heat rates over 250 x 10^6Btu/b. Meeting these standards requires expensive scrubbers for combustion of all but lowest-sulfur coal; wood combustion, however, requires no scrubbers and therefore may have a considerable cost advantage. Emissions from large and small boilers may be regulated by the states. State regulation and regional fuel prices affect the competition between coal and wood for industrial steam generation. For example, small boilers in Minnesota can burn high-sulfur coal without scrubbers. This lax regulation, coupled with relatively low coal prices, gives coal a considerable advantage over wood in small boilers. For large boilers in Minnesota neither fuel has a cost advantage. On the other hand, high coal prices and stringent regulation for all boilers in Connecticut give wood a competitive advantage.

37380 **Optical particle counting, sizing, and velocimetry using intensity deconvolution.** Holve, D.J.; Annen, K.D. (Sandia National Labs., Livermore, CA). *Optical Engineering;* 23: No. 5, 591-603(Sep-Oct 1984).

This paper describes the technique and presents the theory of particle sizing by the intensity deconvolution method. An example of the successful measurement of particle size distributions in an industrial reactor using the backscatter configuration is given, and the results are discussed. Measurements using the forward scatter configuration of particle size distributions and velocities for coal/water slurry combustion are described. A discussion of the size resolution, accuracy and error analysis of the technique is presented. 27 references, 17 figures.

37381 **Acoustic enhancement of pulverized coal combustion.** Faeser, R.J. (Aerojet Energy Conversion Co., Sacramento, CA 95813). pp 8 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—). Contract AC22-81PC40270.

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

The influence of high intensity sound on the rate of combustion and NO/sub x/ generated by a pulverized coal flame was investigated. A bench scale research combustor utilizing plug flow and burning 5 lb/hr (2.3 kg/hr) of 44 μm Illinois #6C coal was tested with and without sound applied to the combustion zone. Sound intensities of up to 149 dB at frequencies from 1100 Hz to 3000 Hz were applied to the combustion zone. The experiments showed significant increases in rate of combustion and increased NO/sub x/ generation.

0150 Marketing And Economics

REFER ALSO TO CITATION(S) 37333, 37355, 37358

37382 **(DOE/OR/20837—H1) Modifications to the International Coal Trade Model. Final report.** (Science Applications, Inc., Wayne, PA (USA)). 14 Dec 1984. Contract AC05-81OR20837. 82p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012981.

This report describes modifications made to the International Coal Trade Model (ICTM) to assist the Energy Information Administration (EIA) in improving the coal supply modeling capability of the model. The ICTM uses supply curves for each coal exporting country that show the price of coal shipped from each export region as a function of cumulative production. Supply curves for United States regions are derived from output of the Resource Allocation and Mine Costing (RAMC) model. The ICTM changes described in this report had the following objectives: (1) modify the RAMC program for use with Australia, Canada, and South Africa so that it can be used with the information in the ICF document; (2) using the information in the ICF document, prepare input files for Australia, Canada, and South Africa in the format required for the modified RAMC; (3) simplify and automate the previous process of generating aggregated ICTM supply curves from RAMC output for Australia, Canada, South Africa, and the US; (4) develop revised estimates of domestic demand for coal from each supply region in Australia, Canada, and South Africa; and (5) use the new input files as a basis to examine the sensitivity of ICTM forecasts to variations in supply costs in Australia, Canada, and South Africa.

37383 **(PB—86-184652/XAB) Recent developments in US coal exporting capability. A technical report pertinent to exporting US coal to Pacific Rim markets.** (International Trade Administration, Washington, DC (USA). Office of Energy). Feb 1984. 103p. (ITA/OE—86/05). NTIS, PC A06/MF A01.

This technical report was prepared by the U.S. Departments of Energy and Commerce for the Energy Subgroup of the U.S.-Korean Economic Consultations. The document contains information and data addressing the technical and commercial considerations pertinent to exporting U.S. coal to Pacific Rim markets, including Korea. The purpose of the report is to provide information about ways to increase US coal exports to Korea.

37384 **(PB—86-184686/XAB) Cost comparison of selected US and Colombian coal mines - analyses of cost-structure differences between steam coal mines in US and Colombia.** (International Trade Administration, Washington, DC (USA). Office of Energy). Jan 1986. 78p. (ITA/OE—86/04). NTIS, PC A05/MF A01.

The report presents the results from a study comparing the mine-mouth costs among selected steam-coal mines in Colombia and the United States. The study was done in response to a Congressional request to identify the differences in production costs, and those factors, including mine health, safety, and environmental requirements, that account for the difference. Three sets of mines are compared to determine the basic cost differences in mining between the two coal countries.

0160 Health And Safety

REFER ALSO TO CITATION(S) 37278, 37333, 37337, 37338, 37339, 37340, 37341, 37348, 37349, 38475, 38958

37385 **(DOE/PC/20103—T2) Evaluation of the occupational safety and health program at the Pittsburgh Energy Technology Center. Final report.** (JRB Associates, Inc., McLean, VA (USA)). [1986]. Contract AI22-79PC20103. 89p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86007416.

The assessment is the preliminary step in developing a model occupational safety and health (OSH) program for energy technology facilities. PETC was selected for assessment because it is one of

the larger facilities. Regulations and guidelines contained in DOE Order ETF 5480.1, Office of Federal Energy Programs, Occupational Safety and Health Manual formed the basis for the evaluation. Additional information was contained in Executive Order 12196 and 29 CFR 1960, both of which relate to occupational health and safety programs for federal employees. This evaluation determines what is needed for compliance with current guidelines; allows for an evaluation of the current regulations and guidelines in terms of applicability and reasonableness; provides input as to what a model program should contain; and provides information on the cost of implementing a model program. The primary objective was to evaluate the OSH program elements and procedures for implementation as opposed to an evaluation of facility compliance with specific OSHA standards.

37386 **(DOE/PC/50001—T1) Epidemiological study of Solvent Refined Coal (SRC) workers. Final report, August 1982-December 1985.** Wen, C.P.; Weiss, N.S.; Bailey, W.J. (Chevron Corp., San Francisco, CA (USA). Medical Staff). 31 Mar 1986. Contract AC22-82PC50001. 39p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011840.

This program was initiated for the purpose of monitoring the health status of Solvent Refined Coal (SRC) workers and determining the potential long-term health effects associated with exposure to SRC process materials. The three SRC facilities studied include the SRC pilot plant at Ft. Lewis, Washington (from 1974 through 1981), the P-99 process unit located at Harmarville, Pennsylvania (from 1975 through mid-1981, and benchscale work from October 1984 to the present) and the Merriam Research Laboratory at Merriam, Kansas (from 1962 through May 1984). The methods employed for data collection are described and the success of each discussed. Data collected on each worker included medical history, job history/exposure data, demographic data, lifestyle factors, reproductive history, current vital status, and death information, if applicable. In light of the dramatic cut-back in SRC activities consistent with the overall industry phase-down of synfuel research, coupled with the termination from employment of over 85% of the cohort, the decision was made by Chevron (formerly Gulf) not to extend the project beyond the end of 1985. Therefore, this report describes the work completed through June of 1985 in terms of updating the individual data files, describing the work performed, and presenting descriptive statistics as appropriate. Due to the limited nature of the data collected to date, and the incompleteness of data on many individuals because of short service, no statistical analyses or risk assessments were performed. 4 refs., 4 tabs.

37387 **(MSHA/IR—1149) Quality assurance program for field health laboratories.** Treaftis, H.N.; Parobeck, P.S. (Mine Safety and Health Administration, Arlington, VA (USA)). 1984. 20p. NTIS, PC A02/MF A01. File Number DE86901509.

The Federal Mine Safety and Health Act of 1977 (and previously the Federal Coal Mine Health and Safety Act of 1969) established mandatory dust standards for coal mines. Title II requires the Secretary of Labor to make frequent inspections of coal mines to determine compliance with the mandated 2.0 mg/m^3 respirable dust standard. Such inspections are made by representatives of the Secretary, who are coal mine inspectors of the Mine Safety and Health Administration (MSHA). Sampling equipment used to assess respirable dust concentrations is calibrated and maintained at local field laboratories located in each Coal Mine Safety and Health district. Samples collected during inspections are weighed and analyzed at these laboratories. A selected number of laboratories are also qualified to weigh operator samples in accordance with provisions promulgated in Title 30, Code of Federal Regulations, Part 70. This paper describes the quality assurance program conducted to assure the performance integrity of the field laboratories in the maintenance and calibration of respirable dust sampling equipment and the weighing of respirable coal mine dust samples. 18 figs.

37388 **(ORNL/TM—10070) Integrated report on the toxicological mitigation of coal liquids by hydrotreatment and other processes.** Guerin, M.R.; Griest, W.H.; Ho, C.H.; Smith, L.H.; Witschi, H.P. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 129p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86012606.

Research here on the toxicological properties of coal-derived liquids focuses on characterizing the refining process and refined products. Principle attention is given to the potential tumorigenicity of coal-derived fuels and to the identification of means to further reduce tumorigenicity should this be found necessary. Hydrotreatment is studied most extensively because it will be almost certainly required to produce commercial products and because it is likely to also greatly reduce tumorigenic activity relative to that of crude coal-liquid feedstocks. This report presents the results of a lifetime C3H mouse skin tumorigenicity assay of an H-Coal series of oils and considers the relationships between tumorigenicity, chemistry, and processing. Lifetime assay results are reported for an H-Coal syncrude mode light oil/heavy oil blend, a low severity hydrotreatment product, a high severity hydrotreatment product, a naphtha reformate, a heating oil, a petroleum-derived reformate, and a petroleum derived heating oil. Data are compared with those for an earlier study of an SRC-II blend and products of its hydrotreatment. Adequate data are presented to allow an independent qualitative assessment of the conclusions while statistical evaluation of the data is being completed. The report also documents the physical and chemical properties of the oils tested. 33 refs., 14 figs., 53 tabs.

37389 **(PB—86-187341/XAB) Suppression of coal-dust explosions with inert dusts and moisture. Research report.** Enright, R.J. (Sydney Univ. (Australia). School of Civil and Mining Engineering). Mar 1985. 35p. (R—468). NTIS, PC A03/MF A01.

An investigation was carried out to determine the effectiveness of limestone dust as an inhibiting agent in coal-dust explosions.

37390 **Coal conversion (liquefaction/gasification): engineering considerations and relationships among physical, chemical and toxicological properties of resulting materials.** Gray, R.H.; Drucker, H.; Massey, M.J.; Reilly, C.A.; Renne, R.A.; Wilson, B.W. (Pacific Northwest Lab., Richland, WA). pp 868-871 of Proceedings of condensed papers of the 7th Miami international conference on alternative energy source. Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1986). (CONF-851201—).

From 7. Miami international conference on alternative energy sources; Miami Beach, FL, USA (9 Dec 1985).

Over the last decade, a substantial data base has been developed concerning the physical and chemical characteristics and toxicological properties of coal conversion (liquefaction and gasification) materials. This work, sponsored by the U.S. Department of Energy, has evaluated products and byproducts that were derived from process options that in many cases were operated under a variety of conditions and configurations. The authors have recently completed a major effort to compile, integrate and evaluate the chemical, physical, toxicological and engineering data base that has been developed. The effort has involved several laboratories, organizations and individuals that have assisted in the area of toxicologiacal effects, engineering, chemistry, and worker exposure. This paper summarizes the results of this effort soon to be published in book form, and indicates those properties/characteristics of coal conversion materials that are most directly related to the toxicological effects. Toxicological end points discussed emphasize mutagenic and carcinogenic responses.

0170 Legislation And Regulations

REFER ALSO TO CITATION(S) 37342

37391 (CONF-8509275—, pp 165-174) **Aspects on the reclamation of cut-away bogs.** Stenbeck, G. (The National Environmental Protection Board, Solna, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Commercial peat harvesting in Sweden calls for a special permit granted by the County Administration. This permit comprises regulations for the exploitation of peat as well as special demands for the reclamation of the exploited area. These demands are varying owing to the fact that knowledge of the best ways to treat

harvested areas is lacking, as are guidelines for a uniform appraisal of reclamation. Regarding that energy production takes place during a long time, it might be difficult to lay down a certain land-use alternative in the County Administration's permit. Several reclamation strategies are possible. As one extreme case stand those areas where you work with some sort of continuous reclamation, e.g. you make the necessary preparations as soon as the harvested areas are abandoned. As another extreme stand those harvested areas which are left untreated for several years after the exploitation has been completed. The advantage of such a procedure is that you are not stuck to one single land-use alternative settled beforehand. In Ireland as well as in Great Britain they also emphasize the prevailing good opportunities to realize the best possible land-use in an organized form after the exploitation has been completed. All possible alternatives are to be examined but one needs more time to be able to give the best land use direction for each separate case. In Finland, as well as in the USSR, most of th research work seems to be confined to silvicultural utilization of cut-over bogs. In Sweden, so far, the corresponding investigations are confined to a few experimental areas.

37392 (CONF-8509275—, pp 343-353) **Environmental regulations to the development and utilization of Minnesota's peat resources - energy production.** Haberman, K.M. (Minnesota Pollution Control Agency, Roseville, USA). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

Peatland development and peat utilization activities in Minnesota, are subject to various local, state, and federal laws and regulations. In Minnesota, the Minnesota Pollution Control Agency (MPCA) is charged with the power and duties to administer and enforce the laws and regulations relating to the prevention, control, and abatement of air and water pollution, and to the management and disposal of solid and hazardous waste. This paper provides an overview of the environmental laws and regulations administered by the MPCA by focusing on three specific activities. 1 the combustion of peat fuels, 2 the discharge of drainage water from fuel peat mining sites, and 3 the disposal of ash generated by the peat combustion process. The discussion regarding the combustion of peat fuels (listed above as 1) shall be limited to the laws, regulations, and standards pertaining to facilities which utilize peat for 'indirect heating'. Indirect heating is defined by MPCA rules as the process of burning fuels to produce steam, hot water, or hot air where the products of combustion do not have direct contact with the heated medium. These types of facilities generally consist of boilers or furnaces which are utilized for commercial and large-scale residential heating. While only three activities will be discussed, the regulations applicable to these activities provide examples of each of the three major areas of responsibility of the MPCA, namely, air quality, water quality, and solid and hazardous waste disposal, and are sufficiently broad to have general application to other types of peatland develpment and peat utilization activities, such as peat gasification, the drainage of water from the horticultural peat mining sites, and the disposal of wastes (liquid and solid) generated by the production of industrial chemicals. With 7 tables and 3 refs. (author).

37393 (PB—86-182029/XAB) **Potential effects of Section 3 of the Federal Coal Leasing Amendments Act of 1976. Special report.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Mar 1986. 199p. (OTA-ITE—300). NTIS, PC A09/MF A01.

Section 3 of the Federal Coal Leasing Amendments Act of 1976 (FCLAA) forbids the issuance of any new Federal onshore mineral leases to any person or company that owns a Federal coal lease that is not producing coal in commercial quantities and has been held for 10 or more years...This OTA special report analyzes the potential effects of section 3 and legislative options for promoting timely production from Federal coal leases.

02 PETROLEUM

0201 Reserves

REFER ALSO TO CITATION(S) 37469

37394 (CONF-8408191—Pt.4, pp G8 1-32) **Norwegian continental shelf - discoveries and related research challenges.** Bergsager, E. 1984. NTIS (US Sales Only), PC A11/MF A01. File Number DE86752310.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

In 1969 the discovery of Ekofisk, the first commercial field on the Norwegian continental shelf, was made. Since that time a number of discoveries of oil as well as gas have been made, and a survey is given of the proven petroleum reserves in fields declared commercial. Before 1980 all commercial drilling was limited to the North Sea, south of the 62nd latitude. All production up till now has come from that area. After 1980 three areas have been opened for exploratory drilling off the coast of Northern Norway, But no discovery has been declared commercial yet. when it comes to reservoir geo-modelling in the immediate future, four areas are considered to be of particular importance, namely: three-dimensional seismic data acquisition, processing and interpretation, vertical seismic profiles and other logging tools interpretation of well log readings, and finally the process of migration.

0202 Geology And Exploration

REFER ALSO TO CITATION(S) 37394, 37415, 37486, 39003

37395 **(CONF-8408191—Pt.4) Reduction of uncertainties by innovative reservoir geo-modelling. Pt. 4.** (Offshore Northern Seas -84, Stavanger (Norway)). 1984. 250p. NTIS (US Sales Only), PC A11/MF A01. File Number DE86752310.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

This section of the proceedings contains seven papers covering: The current state of development of the marine 3D seismic survey method; Porosity evolution of truncation traps: diagenetic models and log responses; Prediction techniques from logging tools: are the results confirmed by testing; Frigg field: production history and seismic response; The usage of palynostratigraphy and palynofacies in definition of Troll field geology; The Valhall field - a new geological description; The Norwegian continental shelf-discoveries and related research challenges. Separate abstracts were prepared for each paper of the section.

37396 (CONF-8408191—Pt.4, pp G2 1-20) **Current state of development of the marine 3D seismic survey method.** Lucas, A.L. 1984. NTIS (US Sales Only), PC A11/MF A01. File Number DE86752310.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

The 3D seismic survey method has been developed steadily since its introduction in the middle of the seventies, and today it is established as the best available method of reservoir definition in many circumstances. There remain other cases where, for one reason or another, the seismic method cannot materially contribute to reservoir delineation, and there is no alternative to expensive reservoir definition by drilling. Of course there are also the major contributions made by well logging, sedimentology and production testing, which are always necessary. The 3D seismic survey method can be divided into three parts, namely, data acquisition, data processing, and interpretation. Today it seems fair to describe acquisition techniques as relatively mature and settled, although development continues. The most recent developments have sought to improve the economics rather than enhance the technical specifications itself. Processing techniques are in an intermediate state, being adequate in the simplest cases, but with scope for major enhancements needed in more complicated cases. Interpretation techniques are extremely useful, as the computer graphics being brought into use will allow traditional interpretation of the data to be done more

rapidly, and introduce entirely new processes into the hands of the interpreter. 6 references.

37397 (CONF-8408191—Pt.4, pp G3 1-18) **Porosity evolution of truncation traps: diagenetic models and log responses.** Selby, R.C. 1984. NTIS (US Sales Only), PC A11/MF A01. File Number DE86752310.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

The presence of secondary solution porosity has long been noted in truncation traps in Algeria, Libya and Alaska. More recently solation porosity has been found in many of the trunction traps in the northern North Sea. The distribution of secondary solution porosity is erratic and hard to predict because of several controlling factors. These include the initial mineralogy of the sand, the primary distribution of permeability and the type and extent of early diagenesis. As a general rule, the greatest porosity enhancement occurs in sands with the highest initial permeability, and those with the least stable mineralogy. Concomitant with the development of solution porosity beneath an unconformity a deeper zone of reduced porosity may form. This occurs where saturated meteoric waters presipitate cement where they mingle with deeper connate water. This zone of reduced porosity is sometimes hard to differentiate from seat-seal cements formed after petroleum has invaded a trap in the water zone. In the ordinary way epidiagenetic secondary porosity is largely destroyed by renewed burial of the unconformity. It can be preserved by overpressure or by early petroleum invasion. 37 references.

37398 (CONF-8408191—Pt.4, pp G4 1-26) **Prediction techniques from logging tools: are the results confirmed by testing.** Helgoey, T. 1984. NTIS (US Sales Only), PC A11/MF A01. File Number DE86752310.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

An attempt is made to show how prediction from logging tools can be verified by actual testing. By showing actual examples of petrophysical evaluations a more detailed picture of the procedures leading up to the definitive test intervals, is given. In the evaluation of test intervals correlations to similar zones in neighbouring wells can be of importance. A brief introduction to how this can help the test preparation is also outlined. After the evaluations of the chosen parameters the test is carried out to prove the anticipated model. Actual data from the test in the North Sea are shown. The presented data are analysed, reservoir pressure, temperature and permeability estimated, and hydrocarbon type specified. These parameters were predicted by the use of logging tools, and examples show that good agreements exist.

37399 (CONF-8408191—Pt.4, pp G7 1-56) **Valhall field - a new geological description.** Munns, J.W. 1984. NTIS (US Sales Only), PC A11/MF A01. File Number DE86752310.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

The Valhall field is located in the southern part of the North Sea on the Norwegian side of the borderline with UK. The discovery well was drilled in 1975, and the field went on production in 1982. The production is currently (1984) 55000 barrels oil per day. The Valhall field structure has an area closure in excess of 24000 km^2. The hydrocarbon columm measure approximately 300 meters. The geophysical evaluation of the field is complicated by the existence of a gas-charged tertiary section, which obscures the deeper seismic reflections. Vertical seismic profiles have been utilised in an attempt to resolve the reservoir configuration. Reservoirs occur both in the Tor formation and in the underlaying Hod formation. The Tor formation is represented by a largely allochtonous chalk facies, which thins regionally to the southwest. A crestal graben is developed in which the Tor formation is locally thick. Primary porosity of the chalk varies between 36 to 50 % on the crest of the structure. Preservation of such high porosity is apperently due to formation overpressure inhibiting mechanical compaction of the chalk. 10 references.

37400 (NP—6770110, pp 27) **Conventional and special core analyses.** Springer, N.; Haslund, O. (Danmarks Geologiske Undersoegelske, Copenhagen). Sep 1985. (In Danish). NTIS (US Sales Only), PC A09/MF A01. File Number DE86770110.

Prepared for the Danish Ministry of Energy.

In Establishment of core laboratory competence. Triaxial tests at reservoir pressure. Relative permeability. Standard core laboratory tests.

As a part of the energy research project EM118 j.nr. 22510-9, carried out in cooperation between the Danish Geotechnical Institute - DGI - and the Geological Survey of Denmark - DGU - part 1 describes the results of standard and more specialized core analyses. These were carried out mainly by API-standard methods in the established core laboratory at DGU on 27 core samples of carbonate rocks from geotechnical investigations in Copenhagen, at Storstroemmen and Storebaelt. Furthermore 10 cores from the Danish North Sea supplied by Maersk Oil and Gas have been analysed. The standard analyses involve porosity and permeability analyses (N_2 and brine) on standard plugs. The results appear in table and on crossplots. Detailed compressibility analyses have been performed on 3 chalk samples (1 from Storebaelt and 2 from the North Sea) by means of a digital weight interfaced and controlled by a desk computer for data acquisition, -storage and calculations. The main objective was to secure basis core laboratory data for classification of chalk samples used for triaxial tests and 2-phase permeability tests described in part 2 and 3 of the report. (author). 5 refs.

37401 (NP—6770110, pp 80) **Triaxial test of the reservoir carbonate rock pore compressibility - elastic deformation parameters - compression yield strength.** Foged, N. (Geoteknisk Inst., Lyngby, Denmark). Sep 1985. (In Danish). NTIS (US Sales Only), PC A09/MF A01. File Number DE86770110.

Prepared for the Danish Ministry of Energy.

In Establishment of core laboratory competence. Triaxial tests at reservoir pressure. Relative permeability. Standard core laboratory tests.

As a part of the energy research project EM118 j.nr. 22510-9, carried out in cooperation between the Danish Geotechnical Institute - DGI - and the Geological Survey of Denmark - DGU -, part 2 describes the development of a triaxial test technique for reservoir pressures and a test programme on chalk samples from Danian and Maastrichtian. The triaxial apparatus based on Hoek-cells with capabilities in the present range of reservoir pressures is described in detail. It is fitted with automatic data collection, calculation and presentation of test results done by datalogger and microcomputers interfaced with printer and plotter. The sample deformations are measured with vertically and horizontally electric strain guages mounted directly on the chalk sample surface. The volume deformation is found by weight interfaced with the datalogger. The results of a pilot test serie on 6 samples from reservoirs in the Danish North Sea are presented in detail: pore compressibility csub(p), modulus of elasticity E, Poisson ratio ν and strength properties like yield stress and effective cohesion and friction angle. By comparison with published and released test results on chalk samples from the North Sea area it is concluded, that the development project has resulted in a high technology test facility with advantages to recent standard techniques. It is now commercial and in action testing compaction and plastification problems in high porous chalk reservoirs in the North Sea. Thereby one of the objectives of the project is reached by establishing core laboratory competance at DGI with respect to reservoir rock mechanics. (author). 15 refs.

37402 (NP—6770110, pp 6) **Capillary pressure measurement in a pressure membrane device.** Foged, N. (Geoteknisk Inst., Lyngby, Denmark). Sep 1985. (In Danish). NTIS (US Sales Only), PC A09/MF A01. File Number DE86770110.

Prepared for the Danish Ministry of Energy.

In Establishment of core laboratory competence. Triaxial tests at reservoir pressure. Relative permeability. Standard core laboratory tests.

37403 **(PB—86-188406/XAB) Selected papers from the annual meeting of the British Association for the Advancement of Science held at Strathclyde, Scotland, August 26-30, 1985, Section C.** (British Association for the Advancement of Science, London). 1985. 180p. NTIS, PC A09/MF A01.

The report covers topics on role of the British Geologic Survey in Strategic Geology; Environmental Geology of Glasgow; Geothermal Environment of Scotland; A SWOPS Vessel for Exploiting a Small North Sea Oil Field; Future Techniques for North Sea Oil Exploration; Future Potential for Oil and Gas Discoveries on the U.K. Continental Shelf; British Government North Sea Oil Development Objectives and Achievements; Onshore Oil Exploration in the U.K.

37404 **Gas-gun experiments determine forces on penetrators into geological targets.** Forrestal, M.J.; Lee, L.M.; Jenrette, B.D.; Setchell, R.E. (Sandia National Lab., Albuquerque, NM). pp 6 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—). Contract AC04-76DP00789.

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

The authors developed a convenient laboratory procedure to determine forces on projectiles penetrating geological targets. Gas guns were used to accelerate foundry core targets (a simulated soft sandstone) to steady velocities, and the targets subsequently impacted 20.6-mm-dia penetrators instrumented with piezoelectric accelerometers. Rigid-body acceleration data were recorded for one ogival and two conical nose shapes for impact velocities between 0.2-1.2 km/s.

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REFER ALSO TO CITATION(S) 37465, 37489, 38239, 38666, 38674, 38675, 38676

37405 **(CONF-8404306—) Underwater technology conference -84. Deep water technology.** Andersen, J.A. (Norges Landbrukshoegskole, Aas. Fysisk Inst.). 1984. 455p. NTIS (US Sales Only), PC A20/MF A01. File Number DE86752136.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

The conference proceedings contain 29 papers reflecting the challenges to industry and research in developing the oil and gas reserves on the Norwegian continental shelf. The following topics are covered: Underwater production systems; Field development plans and proposals; Existing underwater production systems; Equipment and system testing; Underwater operations; Monitoring, inspection and repair; Intervention - pipelaying and welding. Separate abstracts were prepared for 8 papers of the proceedings.

37406 (CONF-8404306—, pp 71-90) **Gullfaks A - Subsea production.** 1984. NTIS (US Sales Only), PC A20/MF A01. File Number DE86752136.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

The Gullfaks field is an oil and gas field on the Norwegian continental shelf, some 140 km from the coast of Norway and ca 20 km southeast of the Statfjord field. The owners of the Gullfaks field (Statoil, Norsk Hydro and Saga) have approved a proposal for accelerated production by using subsea wells. Five wells will be completed in the first year of production from the Gullfaks A platform. The production plateau will thereby be reacted one year earlier than planned before. This will improve the economy of the Gullfaks phase one development. In addition it will give the operation and the partners valuable experience in subsea technolgy. The paper gives a technical description of the system together with time schedules and plans for testing.

37407 (CONF-8404306—, pp 161-172) **Computer simulation program for reliability assessment of subsea oil/gas well cluster.** 1984. NTIS (US Sales Only), PC A20/MF A01. File Number DE86752136.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

A presentation is given of a new computer program for simulating production effectiveness from a subsea oil/gas well cluster. The program represents one of the first steps in a research activity for improving the reliability and effectivity of subsea production systems. It is exemplified on a production system consisting of a central unit linked together with a number of subsea wells. The simulation program is a versatile tool when planning production system configurations and when deciding maintenance strategies it can be used for reliability assessments that cannot be solved analytically, e.g. by Markov techniques. Several options for sensitivity analyses are included. Effects on the production effectiveness by varying one or more input parameters are readily obtained. This is demonstrated through some examples.

37408 (CONF-8404306—, pp 283-299) **On-line component ratio measurement of oil/gas/water mixtures using an admittance sensor.** 1984. NTIS (US Sales Only), PC A20/MF A01. File Number DE86752136.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

The operator of a production platform is primarily interested in which types of fluids a well is producing and how quickly these different components are being produced. The component ratio and production rate of a well vary during the life of a field. To optimize production, measurement of each well's output is thus desirable. Current designs for subsea production systems lack means of continuously measuring three-component flows. A new method of component ratio measurement is described. The fraction of oil, gas and water flowing between two insulated electrode plates is determined by measuring both the electrical conductance and suseptance across the sensor. A preliminary evaluation of the new measurement system has been performed using a process oil/ water/air mixture. The method is not limited to small pipe diameters. The only possible limitation is that for low velocities in very large pipe diameters an in-line mixer may be required. Advantages of this new system are that real-time measurement of void fraction and water content is possible if a non-intrusive rugged sensor is used, and there are no range limitations, as each component may be measured for any given concentration. 4 references.

37409 **(CONF-8404306—1) Oseberg field development. The role of subsea production systems.** Hermansen, B.; Boge, M. (Norges Landbrukshoegskole, Aas. Fysisk Inst.). 1984. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752312.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

The Oseberg field is located on the continental shelf of Norway, some 140 km west of Bergen, and the water depth in the area is about 105 m. The production will start 1 April 1989. The field will be developed partly by conventional platforms and partly by subsea completed wells. Subsea completed wells are included in the Oseberg field development to provide accelerated production, to reach the reservoir area outside the platform area and finally, as an option to reduce overall investments. The links between the subsea wells and the platforms shall include production flowlines, water injection lines (corrosion, wax, hydrates), test lines and control cable. As the subsea completed wells will constitute a significant part of the entire Oseberg field development, only well proven technology will be used.

37410 **(CONF-8408191—Pt.1) Subsea technology - extrapolation or innovation. Pt. 1.** (Offshore Northern Seas -84, Stavanger (Norway)). 1984. 191p. NTIS (US Sales Only), PC A09/MF A01. File Number DE86752137.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

This section of the proceedings contains 10 papers covering: Two field case histories; Advancement of subsea technology through experience: Tazerka floating production system and Cormorant underwater manifold centre; Production risers for the future; Articulated column as a production riser in 300-400 m water depth; Flexible risers for floating production; State of art of subsea pipeline connection; Norwegian industrial involvement - potentials

and objectives; Critical hardware and control aspects of subsea production systems; Troll development - the technological challenge; The future of subsea production. Separate abstracts were prepared for two papers of the section.

37411 (CONF-8408191—Pt.1, pp S3.I 1-13) **Production risers for the future.** 1984. NTIS (US Sales Only), PC A09/MF A01. File Number DE86752137.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

From the evaluation of possible application areas for future floating production platforms in the North Sea it is concluded that future riser systems are likely to be developed for more than 200 meter water depth with in-excess of 12 riser tubulars. An analysis of the features of conventional drilling riser technology leads to the conclusion that extrapolation from this technology to meet future riser system specifications is likely to be unfruitful for North Sea applications. For this reason innovative riser designs need to be developed to meet the demands of future floating production systems. The Subsea Boom riser system is an example of an innovative approach that has resulted in a design with a minimum downtime and a high safety standard. A summary of the characteristics for this rather special application of the Subsea Boom riser principle is given.

37412 (CONF-8408191—Pt.3, pp F9 1-10) **Petroleum developments offshore northern Norway.** Ager-Hanssen, H. 1984. NTIS (US Sales Only), PC A13/MF A01. File Number DE86752309.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

The exploration activity on the northern Norwegian continental shelf is still at an early stage. It has so far been succesaful, but the geological indications suggest that the petroleum is very likely to be distributed on smaller fields than in the south. This calls for a new approach where one has to consider a regional development rather than a field development. Only on such a basis it will be possible to develop the necessary infrastructure in a cost effective manner. The deep water, the distributed hydrocarbons and the long distance to the market call for the development of more cost effective technology than what is available today. The development of such technology is well under way, but there are still a number of technological issues to be resolved.

37413 (CONF-8408191—Pt.3, pp F13 1-19) **Development of new oil and gas fields and the need for technological innovation.** Dijksma, I.H.F. 1984. NTIS (US Sales Only), PC A13/MF A01. File Number DE86752309.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

An approach is discussed by which the oil and gas industry may blend both traditional and innovative solutions to the problems posed by the requirement to develop hydrocarbon reserves in increasingly more hostile and difficult environments. While it is almost impossible to state specific criteria for achieving a "right" mix, it is possible by reviewing industry developments over the last two decades to suggest a general approach, which both capitalises on the experience gained in the so called traditional areas of busines and yet allows the user of innovative ideas and concepts to not economic and/or environmental constraints imposed in new areas of operation.

37414 **(CONF-8408191—Pt.5) Improved offshore recovery. Pt. 5.** (Offshore Northern Seas -84, Stavanger (Norway)). 1984. 121p. NTIS (US Sales Only), PC A06/MF A01. File Number DE86752311.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

This section of the proceedings contains five papers covering: Improving recoveries from offshore chalk reservoirs; Improved recovery from thin oil sands, Part I Frigg field; Part II Troll field; Part III Balder field; Improved offshore recovery-state of the art: Separate abstracts were prepared for each paper of the section.

37415 (CONF-8408191—Pt.5, pp R2 1-33) **Improved recovery from thin oil sands. 2. Pt. Troll field.** Reinholdtsen, B. 1984. NTIS (US Sales Only), PC A06/MF A01. File Number DE86752311.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

The Troll oil field is located in the Norwegian Trench of the North Sea, where the water depth ranges from 320 to 350 m. The large gas accumulation in the block 31/2 part of the field overlies a thin oil colums. Based on the thickness of this oil column the accumulation has been split into two distinctly different areas, namely the gas province containing the bulk of the gas overlying an up to 14 m thick oil column, and the oil province in a 2 to 28 m thick oil column. A large proportion of the oil is contained in the clean highly permeable sands. Single well simulation models based on matched performances of actual field tests have been applied to predict oil well behavior under various conditions. In the gas province initial oil rates are envisaged not to exceed 1400 bbl/d under the most favorable conditions. In the oil province initial oil well rates up to 5000 bbl/d seem feasible, where high permeability sands prevail. However, according to the present gological interpretation micaceons sands dominate along the western flank of the oil province. Preliminary studies indicate that oil recovery from this area may be problematic, with initial oil rates in the order of 1000 bbl/d or less. In conclusion, oil production is presently considered viable from the part of the oil column is contained in predominately clean highly permable sands.

37416 (CONF-8408191—Pt.5, pp R2 1-27) **Improved recovery from thin oil sands. 1 Pt. Frigg field.** Hamre, S. 1984. NTIS (US Sales Only), PC A06/MF A01. File Number DE86752311.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

The Frigg field overlaps the borderline between the Norwegian and the British sector of the North Sea, some 190 km off the coast of Norway. The water depth at field loction is ca 100m. After the drilling of a few appreciation wells, it was realized that Frigg was a giant natural gas field with 269 x 10^9 m^3 gas in place, and the gas volume rests on a thin oil disk. The field was declared commercial in 1972, and the production started in 1977. In 1972, after the drilling of 4 wells, the thickness of the oil disk was believed to be about 10 m. The oil in place between the two contacts was estimated to 225 x 10^6 tons, and a study was undertaken to look into the possibility of commercial oil exploitation. The problem was that if the oil was to be exploited, this had to be done before or at the same time as exploiting the gas. To establish production profiles, taking into account the effects of triphasic coning and vertical displacement of the oil disk, studies were performed on a 2-dimensional triphasic radial model of high performance. In order to find the most favorable case to study further on the model, several cases were studied for 100 days. The most interesting case, which turned out to be the one of intensive production of oil and water, was studied further on the model for a period of 4 years. But due to the low oil production rate found, the case was not run any further.

37417 (CONF-8408191—Pt.5, pp R4 1-14) **Improved offshore recovery. State-of-the-art.** Gregg, D.E. 1984. NTIS (US Sales Only), PC A06/MF A01. File Number DE86752311.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

Improved oil recovery starts with the collection of data from the discovery well. Reservoir analysis and development planning are the key to a successful program. These elements not only control the recovery mechanism and the facilities to implement production, but must provide flexibility to adjust at various stages of depletion. Reservoir management during the producing phase is critical to make the changes in wells, completions, injection rates, and equipment to maximize rates and ultimate recovery. Recovery will also be improved by exending producing life through minimizing operating costs, royalty and taxes. These are challenges that have not yet been faced extensively in the North Sea. They will require new thinking by operator, and for the latter items, serious policy considerations by governments. Enhanced recovery processes for the North Sea reservoirs with their high temperatures and

remote, hostile, offshore locations are still in the research and development stage. The most promising method appears to be miscible flooding.

37418 (CONF-8408191—Pt.5, pp R1 1-24) **Improving recoveries from offshore chalk reservoirs.** Griggs, J.F.; Wiborg, R. 1984. NTIS (US Sales Only), PC A06/MF A01. File Number DE86752311.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

Chalk is not considered to be one of the most common reservoir rocks. The largest and most prolific chalk reservoirs discovered to date are located in Norwegian waters, and the largest chalk field is the Ekofish field in the North Sea. A total of thirteen chalk fields have been discovered in Norwegian waters, and eight of these fields have been developed and placed on production. Four of the fields are gas condensate fields, while the other nine are classified as oil fields. Recognizing that primary depletion from the five Phillips Norway Group operated chalk formation oil fields would only recover between 16 an 17% of the stock tank oil in the ground, Phillips and its partners began evaluating enhanced oil recovery (EOR) possibilities during the 1970s. A screening process was used to narrow down the possible enhancement schemes and to enable concentration on those process that merit detailed study and investigation. Based on the screening process, it was concluded that for the Ekofisk field, waterflooding has the best chance of displacing oil from the fractured chalk reservoir, because of capillary imbibition. Water can be imbibed from the fractures into the rock matrix, thus displacing oil, provided that the rock wettability and capillary characteristics are favorable. None of the other EOR processes have this advantage except thermal, which can displace oil from the matrix by heat conduction, but thermal EOR processes are not practical in the Ekofish area for several reasons. Furthermore it may be possible that some, as yet unknown, surfactant could be added to the water to change the wettability and to improve capillay imbibition. 20 references.

37419 **(DGMK—295) Basical investigations for the selection and preparation of field application of tertiary oil recovery by chemical flooding. Final report.** Albertsen, M. (Deutsche Gesellschaft fuer Mineraloelwissenschaft und Kohlechemie e.V., Hamburg (Germany, F.R.)). 1985. 74p. (In German). NTIS, PC E09; Available from NTIS as TIB/B86-06438.

Despite a number of field tests of chemical flooding as a tertiary oil recovery process, especially in the USA, combined surfactant and polymer flooding in particular have not yet by any means become fully ready for application from the technical and scientific points of view. Above all, due to the specific salinity conditions of many German reservoirs, chemicals used and process control are subjected to exacting requirements. Without precise knowledge of the chemical-specific mechanisms the selection and planning of field projects involve too high, not calculable economic risks. To improve the state of knowledge, research centres and oil production companies have been cooperating since 1981 on this joint DGMK project. The work of this project can be subdivided as follows: Investigations on the selection and evaluation of surfactant/polymer flooding media; Investigations of the mechanisms for residual oil mobilization and displacement with surfactants or polymers. Particular emphasis is placed upon the investigation of the phase behaviour of surfactant/oil/water systems, which has been acknowledged as being especially important for the effectiveness of flooding media. (orig.). With 17 figs., 4 tabs.

37420 **(DGMK—295-1) Basic investigations for the appraisal of surfactant flooding media with the example of the ether carboxylates. Part 1 of DGMK-project 295 'Basical investigations for the selection and preparation of field application of tertiary oil recovery by chemical flooding'. Final report.** Pusch, G.; Neumann, H.J.; Kraft, H.; Tunc, S.; Mueller, T. (Deutsche Gesellschaft fuer Mineraloelwissenschaft und Kohlechemie e.V., Hamburg (Germany, F.R.)). 1985. 191p. (In German). NTIS, PC E14; Available from NTIS as TIB/B86-06437.

The basic research conducted with the use of model oil, model porous media, and model reservoir brine for the appraisal of surfactant flooding media is described for the example of the ether carboxylates. The results thus obtained for the phase behaviour under both static and dynamic conditions, as well as the parameters which influence the HLB characteristic, are presented and described. These results constitute the basis for the execution of flooding experiments and for the analysis of the data. The objective of all investigations is the establishment of ultimate criteria for evaluating surfactant flooding media. A mathematical model which effectively describes the oil recovery process during a laboratory flooding experiment is presented. (orig.). With 78 figs., 20 tabs.

37421 **(DGMK—295-3) Investigation of surfactant retention. Part 3 of DGMK-project 295 'Basical investigations for the selection and preparation of field application of tertiary oil recovery by chemical flooding'. Final report.** Pusch, G.; Rosenthal, G. (Deutsche Gesellschaft fuer Mineraloelwissenschaft und Kohlechemie e.V., Hamburg (Germany, F.R.)). 1985. 89p. (In German). NTIS, PC E09; Available from NTIS as TIB/B86-06439.

Within the framework of DGMK project 295 (partial project-3) - Investigation of Surfactant Retention - the question of whether or not the retention exhibits a minimum for a particular phase state (Winsor I, II, III) has been considered. The purpose of the investigation is to systematically analyse the economic problem of chemical loss due to retention of oil-mobilising surfactants stable toward brine in the porous medium of oil reservoirs. Special attention has therby been paid to the effect of the phase state of the water/oil/surfactant/cosolvent system with respect to retention. The experimental results show that the surfactant loss exhibits a minimum in phase state III. (orig.). With 45 figs., 4 tabs.

37422 **(DGMK—295-5) Physico-chemical investigations on polymer-flood media. Part 5 of DGMK-project 295 'Basical investigations for the selection and preparation of field application of tertiary oil recovery by chemical flooding'. Final report.** Rehage, G.; Block, H.; Werhahn, A.K. (Deutsche Gesellschaft fuer Mineraloelwissenschaft und Kohlechemie e.V., Hamburg (Germany, F.R.)). 1985. 100p. (In German). NTIS, PC E09; Available from NTIS as TIB/B86-06440.

The report deals with physico-chemical investigations of watersoluble polymers with special aptitude for Enhanced Oil Recovery. Besides the synthetic polyacrylamide especially the biopolymers Xanthan gum and Skleroglucan are examined. Rheological investigations of the long term stability constitute the main part of the work. The influences of salinity, of oxygen, and of various chemical additives on the degradation behaviour of the polymers were tested at temperatures in the range of up to 90°C. The interpretation of the rheological results was essentially supported by chromatographic analysis of the aged polymer solutions and by model degradations, too. In some cases, Nuclear Magnetic Resonance Spectroscopy (^{13}C) and measurements of the dynamic-rheological behaviour supplied further information. The compatibility of the polymers with surfactants was tested for two representative industrial products. (orig.). With 70 figs., 3 tabs.

37423 **(DOE/BC—85/3) Contracts for field projects and supporting research on enhanced oil recovery. Progress review No. 43, quarter ending June 30, 1985.** (USDOE Bartlesville Project Office, OK). May 1986. 107p. NTIS, PC A06/MF A01; GPO Dep. File Number DE86000259.

Progress reports are presented for field projects and supporting research for the following: (1) chemical flooding; gas displacement thermal recovery/heavy oil; resource assessment technology; extraction technology;environmental technology; and microbial technology. (AT)

37424 **(DOE/BC/10508—36) Bacteria transport through porous media. Annual report, December 31, 1985.** Yen, T.F. (University of Southern California, Los Angeles (USA)). Mar 1986. Contract AS19-81BC10508. 98p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86000274.

This research effort has the following objectives: (1) examination of the interaction between bacteria and geological porous media containing oil and brine; (2) study of transport phenomena of bacteria through porous media under applied pressure; and (3) fa-

cilitation of bacteria transport through geological porous media under naturally-occurring reservoir conditions. In the third phase of the work, the following areas were investigated: (1) improvement of bacterial transport through derivatization of cellular surface functional groups and/or through modification of the rock surface; (2) influence of different nutrients on the surface properties of bacteria and hence on the transport in the geological core. The five chapters in this report have been processed separately for inclusion in the Energy Data Base.

37425 (DOE/BC/10508—36, pp 7-33) **Reversible and irreversible surface charge modification of bacteria for facilitating transport through porous media.** Mar 1986. NTIS, PC A05/MF A01. File Number DE86000274.

In Bacteria transport through porous media. Annual report, December 31, 1985.

Reversible and irreversible surface charge modification of Bacillus subtilis (a gram positive aerobe), Pseudomonas fluorescens (a gram negative species) and polymeric microspheres was attempted using common chemicals. This study was undertaken to see if such chemicals could be used to significantly alter the transport of various bacterial species through porous media. Significant surface charge alterations were observed in the irreversible treatments as shown by zeta potential measurements. The changes were shown to be partly reversible as evidenced by much larger shifts in zeta potential in the presence of the chemicals. Sodium pyrophosphate was found to alter the surface charge most significantly. All the three species showed similar trends. Experiments on the transport of these species through sandpacks showed that their transport was significantly enhanced by the presence of the chemicals. The excellent correlation between high surface charge and transportability clearly suggests that electrostatic interactions between bacteria and sandgrains are a dominant factor in their retention. Other bacterial retention mechanisms such as polymeric adhesion seem to be relatively unimportant, at least for the species studied here. The various mechanisms responsible for the improved transportability and the surface charge modification are discussed. The applications of the study to filtration and microbial enhanced oil recovery are pointed out. 20 refs., 9 figs. 1 tab.

37426 (DOE/BC/10508—36, pp 34-58) **Further investigation of the surface charge properties of oxide surfaces in oil bearing sands and sandstones.** Mar 1986. NTIS, PC A05/MF A01. File Number DE86000274.

In Bacteria transport through porous media. Annual report, December 31, 1985.

The surface charge and zeta potentials of Ottawa sand, and baked and unbaked Berea sandstone were measured using three different techniques: streaming potential, electrophoresis and potentiometric titrations. All three samples behave similarly, showing points of zero charge between 2 and 5. The streaming potential and electrophoresis results are found to be inconsistent with potentiometric titration results reported earlier. An explanation is sought for the differences in the point of zero charge measured by the three methods. Upon leaching the samples with concentrated hydrochloric acid to remove any clay or other mineral impurities, the three methods gave consistent results. This indicates that potentiometric titrations are much more sensitive to impurities in the solid sample than the other two methods. It is concluded that for naturally occurring oxide samples streaming potential and electrophoresis are the most appropriate methods for determining surface potential. The results presented here also provide essential surface chemical data on oxide surfaces in oil bearing sands and sandstones. 17 refs., 10 figs., 1 tab.

37427 (DOE/BC/10508—36, pp 59-66) **Interaction of Pseudomonas putida ATCC 12633 and bacteriophage gh-1 in Berea sandstone rock.** Mar 1986. NTIS, PC A05/MF A01. File Number DE86000274.

In Bacteria transport through porous media. Annual report, December 31, 1985.

Contamination of wellbore rock matrices by bacteria reduces the oil recovery efficiency in MEOR processed. It is advisable to have some alternatives other than using costly chemical bactericides to control the overgrowth of bacteria and hence, the biofouling of the wellbores economically. Lytic inhibition of E. coli B during its diffusive and migratory passage through a rock matrix containing adsorbed bacteriophage T4 has been reported. Analogous experiments were conducted with P. putida ATCC 12633, its phage, gh-1 and phage-resistant in the context of enhanced oil recovery. The experimental results suggest that the lysis of P. putida ATCC 12633 can occur when bacteriophage gh-1 is adsorbed to a rock matrix and that this lytic effect can significantly reduce the migration of cells through porous rock. Tests done with phage-resistant mutants of strain ATCC 12633 showed that physical clogging of the rock was not responsible for the delayed movement of cells through the rock. The study reinforces the possibility of a lytic reduction of pertinent bacteria involved in enhanced oil recovery. 5 refs., 1 fig., 1 tab.

37428 (DOE/BC/10508—36, pp 67-86) **Biotechnological alternative for recovering heavy oil.** Mar 1986. NTIS, PC A05/MF A01. File Number DE86000274.

In Bacteria transport through porous media. Annual report, December 31, 1985.

Currently heavy oils are primarily recovered by thermal methods (e.g., steam flooding and combustion heating) and complemented by other methods such as caustic flooding, micellar flooding, and polymer flooding. In recent years, the development in biotechnology offers an alternative approach of recovering petroleum. However, all the available literature on microbial enhanced oil recovery (MEOR) worldwide is dealing with light oil. This is among the first to experiment on the heavy oil recovery by the application of MEOR with success. Laboratory experiments of recovering heavy oil (Ranger Zone, Long Beach, California, with 17° API gravity) from simulated porous media (e.g., sandpack column and Berea Sandstone core) were initiated. An aerobic, Gram positive, surfactant producing bacterial species Bacillus sp. was inoculated along with nutrient. The time course of oil production by the bio-"huff-and-puff" process developed in this work was recorded. It was found that as high as 40% residual oil left after waterflooding can be recovered. An anaerobic, Gram positive, gas and solvent producing bacterial strain Clostridium acetobutylicum was also used to recover oil from a low permeability (ca. 20 md) limestone core from a Kansas reservoir. It is found that contrary to conventional criteria, low permeability is no longer a limiting factor for applying microbial method to recover oil. Based on state-of-the-art development in MEOR, protocols for future work are suggested. The application of genetic engineering in improving bacterial functions is also forthcoming. 8 refs., 3 figs.

37429 (DOE/METC—86/4064) **Hydrocarbon displacement by carbon dioxide dispersions.** Duda, J.R. (USDOE Morgantown Energy Technology Center, WV). Mar 1986. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86006615.

The US Department of Energy's (DOE) Morgantown Energy Technology Center (METC) is investigating methods to control the mobility of carbon dioxide for use in gas miscible displacements of hydrocarbons that are found in petroleum reservoirs. Carbon dioxide is an excellent hydrocarbon recovery agent, recovering nearly 100% of the oil that it contacts. Like other gases, carbon dioxide has a relatively low viscosity, even at elevated pressures, that contributes to its high fluid mobility. Thus, carbon dioxide channels through high permeability strata, bypasses much of the oil in place, and experiences premature breakthrough at producing wells. The use of foam (a dispersion or an emulsion) is one mobility control method that DOE/METC is investigating. Large-scale natural sandstone cores are being flooded with carbon dioxide dispersions to evaluate the dispersions' worth as displacing fluids. The following are specific objectives of the laboratory investigations: (1) evaluate displacement test results using analytical methods, (2) provide mathematical simulator input data, (3) verify mathematical compositional simulator results, and (4) further understand the viability of using foams as displacing fluids in crude oil reservoirs. A summary of literature concerning the properties of carbon dioxide, the application of carbon dioxide in enhanced oil recovery operations, and the fundamental flow behavior of dispersions is reported here. The literature review facilitated bench-scale displacement tests at DOE/METC that use carbon dioxide dispersions to improve the efficiency of gas miscible flooding. Additionally, preliminary two-dimensional carbon dioxide and carbon dioxide dispersion tests are reported. Results of the tests clearly show that the displac-

ing fluid mobility was reduced when a dispersion was employed. 28 refs., 21 figs., 2 tabs.

37430 (NIPER—138) **State-of-the-art review: microbial field technology. Topical report, Project BE3.** Bryant, R.S.; Douglas, J. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). Jun 1986. Contract FC22-83FE60149. 11p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012582.

Microbial enhanced oil recovery (MEOR) is in the early stages of development. Several companies and laboratories are concentrating on developing microorganisms that produce oil recovery chemicals and can withstand reservoir conditions. The National Institute for Petroleum and Energy Research is developing the techniques necessary for applying the basic knowledge of microbiology to real oilfield situations. This report describes the use of MEOR processes in field tests. An earlier review gave background information on the development and initial use of MEOR processes. Techniques in microbiology are being developed rapidly to culture bacteria with new and unique characteristics. This capability to create bacteria which will perform specific functions in various environments could eventually provide viable and economically feasible MEOR techniques for additional crude oil recovery from some 450,000 stripper wells in the United States. Field projects using microorganisms are increasing in the United States. At present at least 5 to 10 different groups are applying MEOR technology to stripper wells. The economics of the oil industry favor MEOR over other EOR projects. The advance of MEOR techniques should be rapid as more field data are obtained. 7 refs., 2 figs., 1 tab.

37431 (NIPER—150) **Effect of silicate and aluminate ion adsorption on the reaction of quartz and alumina with caustic solution.** Thornton, S.D. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). May 1986. Contract FC22-83FE60149. 22p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012581.

Caustic consumption is recognized as a problem in enhanced oil recovery by alkaline flooding. Chemical reactions which cause caustic consumption are governed by equilibria between reservoir minerals and alkaline solution. Identification of the individual dissolving and precipitating minerals in a given brine and rock system is a critical step in predicting caustic consumption and scale formation in oil recovery by alkaline flooding. This work demonstrates that ion adsorption may have a significant effect on mineral/alkali equilibria. Powdered quartz and alumina were mixed with alkaline solutions containing 0.01 to 0.1 molar hydroxide ion and added silicate or aluminate ion. Each suspension was sealed in a Teflon bottle and shaken continuously for approximately 1 week at 24° or 70°C. Samples of the supernatant were removed periodically and analyzed for the elements silicon and aluminum. The solubilities of quartz and alumina in caustic solutions were found to be reduced significantly by added aluminate and silicate ion, respectively. Adsorption of these ions onto the minerals was also measured. It is postulated that these ions form a protective aluminosilicate layer when they are adsorbed onto the mineral surface. Such an aluminosilicate layer will reduce mineral reactions during alkaline flooding. Two major conclusions result from this work. Adsorbed aluminate and silicate ions can reduce the solubilities of quartz and alumina, respectively. The effect of adsorption on mineral equilibria should be included in a mineral reaction model for alkaline flooding. 18 refs., 5 figs., 8 tabs.

37432 (NP—6770110, pp 42) **Permeability properties at 2-phase flow.** Soerensen, E. (Geoteknisk Inst., Lyngby, Denmark). Sep 1985. (In Danish). NTIS (US Sales Only), PC A09/MF A01. File Number DE86770110.

Prepared for the Danish Ministry of Energy.

In Establishment of core laboratory competence. Triaxial tests at reservoir pressure. Relative permeability. Standard core laboratory tests.

As a part of the energy research project EM118, j.nr. 22510-9, carried out in cooperation between the Danish Geotechnical Institute - DGI - and the Geological Survey of Denmark - DGU -, part 3 describes the implementation of a reservoir condition waterflooding apparatus in the core laboratory at DGU. A procedure for restoring samples (1.5x3" plugs) is developed: Soxhlet cleaning with toluene and methanol, drying at 40 deg C and 40%RH and saturation with synthetic brine and oil respectively. The project objective to make the RCWA-equipment operative at room conditions for water/oil relative permeabilities has been fullfilled. But further developments are proposed to avoid problems with sample saturation and backpressure regulation. Appendix 1 describes the calculation method applied for relative permeabilities based on Welge and Johnson, Bossler and Newmann, Trans. AIME vol. 195 and 216. The calculations have been performed manually, but due to their complexibility and amount it is proposed to use the graphic technique described by Jones and Roszell, JPT May 1978, in future testing. 8 chalk samples from Danian and Maastrichtian including 2 reservoir rock types from the Danish North Sea have been tested and the detailed test results on water/oil relative permeabilities are reported. (author).

37433 (RISO-M—2555) **Numerical integration of systems of differential equations by BDF-methods.** Reffstrup, J.; Houbak, N. (Risoe National Lab., Roskilde (Denmark)). Jun 1985. 44p. (In Danish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752266.

Energiministeriets Energiforskningsprogram. Olie- og gasreservoirmodeller. Rapport, 13.; EFP-82.

Time integration of ordinary differential equations is an essential part of the overall solution procedure in reservoir simulation. The present report gives the theoretical background for a generalized BDF-procedure (backward difference formation). The report includes derivations of expressions for truncation errors, outlines the procedure for a transformation of multistep methods into "single"step methods using the Nordsieck approach. Furthermore a discussion of automatic time step control is given. The automatic time step control is based on a combined use of predictor corrector methods and a continous estimate of the local truncation error. (author).

37434 (SNIAS—52-430-101) **Drilling risers for great water depths: advantage for mass reduction by means of composite materials.** Odru, P.; Guichard, J.C. (Societe Nationale Industrielle Aerospatiale, 75 - Paris (France)). 1985. 12p. (CONF-8510316—1). NTIS, PC A02/MF A01.

From Deep offshore technology (DOT) conference; Sorrente, Italy (21 Oct 1985).

Composite material lines processed from carbon and glass fiber composites were manufactured in pieces of 15 m length and then fitted to an operational drilling riser, in parallel with the working lines. A reduction of dynamic stress was expected. The lines were routinely subjected to 10,000 psi. The results prove satisfactory for high pressure lines. However, the greater fragility of composite hardware versus steel is a factor to be considered when handling the riser.

37435 **Analysis of interference pressure tests in naturally fractured reservoirs with macroscopic fracture and pore system permeabilities and unsteady interporosity flow.** Wijesinghe, A.M.; Kececioglu, I. (Lawrence Livermore National Lab.). pp 311-324 of Proceedings of the SPE Eastern regional conference. Richardson, TX; Society of Petroleum Engineers (1985). (CONF-8511139—).

From SPE eastern regional conference; Morgantown, WV, USA (5 Nov 1985).

Existing pressure test solutions for naturally fractured reservoirs neglect the macroscopic pore system permeability, the wellbore storage and skin factors of the observation wells, and are limited either to single-wells in infinite domains or to concentric wells in circular reservoirs. In this paper, two solutions for interpreting interference pressure tests in naturally fractured reservoirs are presented. The model on which these solutions are based incorporates both macroscopic fracture and pore system permeabilities, an improved unsteady interporosity flow model, and allows for wellbore storage and skin factors of the wells. In the first solution, the pressure response of a shut-in observation well to arbitrarily varying unsteady pressure fields is considered under the assumption that the observation well affects the flow field only locally. In the second solution, a general technique for exactly solving the governing equations for fluid flow in naturally fractured reservoirs with multiple non-concentric circular boundaries is first developed. The procedure is then specialized to two circular boundaries to determine

the pressure changes induced in a circular reservoir by an eccentric flowing well with wellbore storage and skin. These two solutions, used together, will enable the development of pressure tests for determining the location of the center of a circular reservoir in addition to its radius and its hydraulic properties.

37436 **Testing CO_2-foam for mobility control at Rock Creek.** Heller, J.P.; Boone, D.A.; Watts, R.J. (New Mexico Petroleum Recovery Research Ctr.). pp 275-288 of Proceedings of the SPE Eastern regional conference. Richardson, TX; Society of Petroleum Engineers (1985). (CONF-8511139—).

From SPE eastern regional conference; Morgantown, WV, USA (5 Nov 1985).

This paper reports the objectives, design and progress of a field test of "CO_2-foam" as a lowered mobility displacing fluid. It includes the background of mobility control considerations leading to the trial, and describes the influence on it of various operational conditions and constraints. The Rock Creek oil field of Roanoke County, West Virginia, has been produced since 1906 from a low permeability sandstone with high clay content, and is now near the end of economic life. The area utilized in this test is a smaller portion of two ten-acre five-spots that have been subjected to a conventional CO_2 flood and subsequent waterflooding, in addition to gas recycling and primary production. A major goal of the test was to determine whether the oil remaining in this area could be displaced by a slug of thickened CO_2 to form a mobile oil bank that could be detected at a nearby observation well. A second goal was to test the injectivity of CO_2-foam as liquid CO_2 and dilute surfactant solutions were pumped simultaneously down fiberglass tubing into the injection well. The design of the test was based on published measurements of the ability of the chosen surfactant (Alipal CD128) to form a foam-like dispersion with liquid CO_2, on stability at reservoir temperature (73°F; 23°C), on the extent of adsorption onto the reservoir rock, and on the appropriate values of the relative mobility of the CO_2-foam (0.2 cp^{-1}). Although it has been possible to inject the target quantity of CO_2 foam, the injection of chase water has not yet been completed.

0204 Processing

REFER ALSO TO CITATION(S) 38491

0205 Products And By-products

37437 **(AD-A—165642/0/XAB) Emission ft-ir analyses of jet-fuel deposits.** Lauer, J.L.; Seng, G.T. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Mechanical Engineering). 1985. 9p. NTIS, PC A02/MF A01.

Deposits were collected on small flat and removable strips of metal from an aircraft fuel slowly flowing over them for varying lengths of time (up to 14 h). Both the strips and the fuel were heated to about 250 C. The fuel contained oxygen. After every test the deposit weight was determined with a microbalance, and the infrared emission spectrum of the deposit maintained at 100 C was recorded with a specially adapted Fourier spectrophotometer. Deposit thicknesses varied from 22 nm to 500 nm. Plots of deposit thickness squared vs. time were linear, with an abrupt change of slope after five hours of run time. Corresponding to these different slopes were also different infrared spectra, the earlier ones showing strong -C-O- bands around 1100/cm, the latter primarily -C=O bands near 1700/cm. Fuels containing up to 1% of thiphene or pyrrole showed only the latter bands. These results are consistent with a diffusion mechanism dependent on the timely arrival at the liquid-deposit interface of a sufficient concentration of a reaction intermediate.

37438 **(RR-WB—5-15) Traction in elastohydrodynamic lubrication. High contact pressure experiments and a thermal Roelands-Eyring-Maxwell model.** Meuleman, P.K.; Lubrecht, A.A.; Tennapel, W.E. (Technische Hogeschool Twente, Enschede (Netherlands)). Mar 1985. 33p. NTIS, PC A03/MF A01.

Traction experiments for an intermediate and a low viscosity lubricant were carried out on a disk-machine. It is shown that the results can be explained by a thermal Roelands-Eyring-Maxwell model for the lubricant. The order of magnitude of the Eyring shear stress is 1 MPa, and the elastic shear modulus is 10 MPa. The elastic shear modulus of the lubricants increases with pressure and decreases with temperature. The Eyring shear stress increases with temperature and exhibits a small tendency to decrease with increasing pressure. The very thin lubricant shows a much stronger decreasing tendency, but more results are needed.

37439 **A computational model for predicting the life of tubes used in petro-chemical heater service.** Simonen, F.A.; Jaske, C.E. (Pacific Northwest Lab., Richland, Washington). pp 45-54 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-1. Residual-life assessment, nondestructive examination, and nuclear heat exchanger materials. Jaske, C.E. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—).

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

This paper describes a model developed for computer simulation of stresses in heater tubes used in petro-chemical service. The model predicts the damage to the tube material and thus, provides an assessment of both tube design life and residual-life of tubes that have been subjected to service exposure. The analysis procedure has been incorporated into a computer code (TUBE), which has been applied to a number of applications for heat resistant alloys. The focus of these applications has been to address the effect of sustained and cyclic loadings on the predicted service lives of tubes used in elevated temperature service. The model was originally developed at Battelle-Columbus in the 1970s, as part of an industrial group research program on "Materials for Steam Reformer Furnaces." The computer model uses conventional numerical approaches to solve finite element models of two-dimensional creep problems. This paper addresses the practical difficulties of applying such models to real service conditions and real commercial alloys.

0206 Health And Safety

REFER ALSO TO CITATION(S) 37841, 37842, 37843, 37844, 37845, 37846, 37847, 37848, 37849, 38089, 38090, 38092, 38514, 38862, 38863, 38864, 38868, 38869, 38870

37440 (CONF-8404306—, pp 311-325) **Detection and sizing of defects in offshore steel structures by the diffraction of ultrasound.** 1984. NTIS (US Sales Only), PC A20/MF A01. File Number DE86752136.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

The ultrasonic time-of-flight technique has been developed at Harwell for the detection and sizing of defects in metal structures. Its potential for the inspection of thick steel sections has already been demonstrated in the context of reactor pressure vessels and other geometries. More recently its potential for detecting and sizing defects in thinner sections has been evaluated, with particular attention being paid to the geometries encountered in the inspection of offshore steel platforms. The author describes the details of the technique and the instrumentation which is required for both the collection of inspection data and for subsequently analyzing it. The paper also includes a discussion of the application of the technique to sub- sea steel structures, its advantages over other techniques, and it is concluded that the technique is better suited for use subsea than it is for use on platform sections above sea-level. 11 references.

37441 (EPRI-CS/EA/EL—4480, pp 6.7-6.11) **Environmental fate of PCBs in mineral oil spills.** Brown, S.M.; Antipas, A. Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The behavior of a contaminated mineral oil spill was examined by using a simple model describing the behavior of chemical spills. The model was used to examine the behavior of a 10 gallon mineral oil spill contaminated with 200 ppm of either Aroclor 1242

or Aroclor 1260. Volatilization and leaching losses from a mineral oil spill are significantly less than those from an equivalent askarel spill. Thus, mineral oil spills pose considerably less risk. Existing and pending spill cleanup guidelines apply uniformly to both types of spills. 2 references, 1 figure, 1 table.

37442 (EPRI-CS/EA/EL—4480, pp 8.34-8.40) **Diffusional modeling during transformer retrofill.** Atwood, G.R.; Moore, I.R.; Dillon, D.R. (Union Carbide Corp., Tarrytown, NY). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The conceptual strategy used to develop the RECLAS 50/sup sm/ model is discussed. The factors that affect the leaching of askarel fluids from transformers are discussed in detail. They include miscibility, viscosity, temperature, and circulation. A second model, based upon piecewise integration of Fick's second law, is also discussed. The models allow one to estimate the residual PCB left to leach. As a result, transformers can be serviced in a safe, timely, and cost-effective manner. 4 references.

37443 (EPRI-CS/EA/EL—4480, pp 8.41-8.46) **Decontamination of PCB transformers using Ensco, Inc.'s RETRO-1 process.** Tinney, J.L. (Mississippi Power and Light, Jackson). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

ENSCO, Inc. has developed a transformer flushing technique identified as Retro-1. Field tests of the method in cooperation with Mississippi Power and Light are described. The economics of the Retro-1 technique compare favorably with transformer replacement, the only viable alternative for reaching non-PCB status on the transformers. 2 tables.

37444 (EPRI-CS/EA/EL—4480, pp 8.47-8.51) **Products of partial combustion of PCB alternative dielectric fluids.** Claiborne, C.C. (Westinghouse Electric Corp., Sharon, PA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

An experimental program was carried out after an extensive literature search. The initial part of the experimental program was the calculation of thermodynamic equilibria. Subsequently, combustion reaction evaluations were carried out. The fluids studied included: tetrachloroethylene, trichlorofluoroethane, silicone, and mineral oil. None of the combustions produced detectable chlorinated or polycyclic aromatic hydrocarbon particulates. 7 references.

37445 (EPRI-CS/EA/EL—4480, pp 8.52) **PCB transformer decontamination rather than burial.** Topolski, T. (ETI of North America, Inc., Overland Park, KS). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Until this year, PCB transformers required burial at a secure landfill. Since the Environmental Protection Agency is encouraging new technologies rather than burial at landfills, they have permitted a reclamation and recovery facilities for PCB transformer reclamation in Kansas City. This PCB transformer facility is under EPA control. Transformers are received, cleaned to less than 500 ppm, opened, and the internal parts processed through an assembly line operation for PCB removal and extractions. Handling and processing procedures for reclamation to primary metal recovery for smelt are discussed.

37446 (EPRI-CS/EA/EL—4480, pp 8.53-8.59) **Retrofilling askarel transformers - words of caution.** Kinney, J.P. (General Electric Co., Rome, GA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Use of silicone refill fluid in transformers can require design changes relative to askarel transformers. The key differences in properties between askarel and silicone fluid which require design changes are impulse creepage strength, heat transfer capability, thermal coefficient of expansion, material compatibility and lubricity. Each of these problems is discussed, and suggested modified operation is described. Specific guidelines for GE transformers are given. 5 references, 2 tables.

37447 (EPRI-CS/EA/EL—4480, pp 8.60-8.63) **Decontamination of an askarel-filled network transformer.** Dunlop. D.T.D. (B.C. Hydro, Vancouver, British Columbia). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A pilot project was undertaken to determine the feasibility and economics of decontaminating and retrofitting askarel-filled network transformers used in B.C. Hydro's underground distribution system in Victoria, B.C. The steps in the process are described in detail. There were no adverse effects to personnel, plant, or environment, and there were no significant increases in blood PCB levels of employees involved in the work. A conceptual cost-benefit analysis for the process is presented.

37448 (EPRI-CS/EA/EL—4480, pp 8.64-8.66) **PCB removals - options and implementation.** Silvia, F.E. (Boston Edison Co., MA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A general description is provided of some issues, decisions, and options that must be addressed by any company considering disposing of its askarel equipment. A primary consideration in preparing a project plan is the definition of the corporate objective; in this case, how does a particular company wish to deal with its askarel equipment? Establishing the objective is essential to providing an overall direction to the project and to keep it on track in its ensuing stages. It should be based not only on dollar cost, but also on potential future liabilities. Presently available options include retrofill of existing equipment with substitute insulating fluids, the addition of a filtering system to a retrofilled unit, direct replacement of askarel equipment with new equipment, and the do nothing approach which simply maintains existing equipment in accordance with applicable regulations. After alternatives have been evaluated, the corporate objective established and options chosen, an implementation plan must be designed and executed. This plan is essentially a master schedule of when field work will be performed.

37449 (EPRI-CS/EA/EL—4480, pp 9.1-9.4) **After a PCB fire - cleanup inside buildings contaminated with dioxins and furans.** Blackmon, K. (Blackmon-Mooring Steamatic, Fort Worth, TX). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Fire involving PCB transformers at office buildings in San Francisco, California, and Binghamton, New York resulted in the buildings being closed due to the presence of dioxins and furans. Four aspects of the subsequent cleanup of these buildings are presented: approach, procedures, results, and costs. The basic approach used was to clean all surfaces, transferring contaminants from the building and its contents to cleaning agents, cloths and sponges. The cleaning materials were then disposed of as hazardous wastes. Procedures used are separated into several areas and discussed. They include medical surveillance, health and safety plans, decontamination facilities, protective gear, exterior restoration, interior restoration, and building content decontamination. The two buildings under discussion have both been returned to service. The costs of these decontamination efforts has been large; twenty-one million dollars for the San Francisco building, and thirty-eight million dollars for the Binghamton building. More recent decontamina-

tion efforts have been less expensive, as they have built upon the knowledge gained in these initial decontamination efforts.

37450 (EPRI-CS/EA/EL—4480, pp 9.5-9.8) **PCB spill response and cleanup results.** Eisele, P.J. (Detroit Edison, MI). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A history of Detroit Edison Company efforts at PCB equipment removal and PCB cleanup procedures is presented. The management structure set up by the company to deal with PCB-related issues is explained. Company criteria for spill cleanup, developed to be in compliance with current EPA positions, necessitated multiple recleaning of over 200 spill sites.

37451 (EPRI-CS/EA/EL—4480, pp 9.9-9.12) **Managing a PCB fire decontamination.** Kwoka, C. (SOS Environmental Engineering, San Francisco, CA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The unit operations involved in decontaminating a building contaminated by a PCB transformer fire follow a logical pattern. It is the reverse of the transmission route of the contamination. The individual tasks according to priority are: removal of gross contamination, control of the building interior air flow patterns, demolition and removal of contents that cannot be decontaminated, decontamination of the transformer vault, decontamination of the HVAC system including ductwork and air handling units, decontamination of structural surfaces, ductwork and piping exterior surfaces, content decontamination and document restoration. Probably the most important aspect of decontaminating a building is the necessity to control air flow patterns of contaminated air within the building. This can be done by evacuating air from the building from strategic locations and exhausting the air through a vapor-phase activated carbon treatment system. The negative air treatment system effectively decontaminates the air within the building and permits the systematic decontamination of surfaces with the building without the fear of recontaminating surfaces that have already been cleaned.

37452 (EPRI-CS/EA/EL—4480, pp 9.13-9.16) **Managing cleanup of major PCB-contaminated sites.** Speed, N.A.; Parker, D.S.; Clister, W.E. (Brown and Caldwell, Walnut Creek, CA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

An overview of PCB concerns and regulatory policies applicable to major PCB-contaminated site is provided. Managing the correction activities at a major PCB-contaminated site is discussed by addressing remedial activities as three dynamic and interrelated phases: Site investigation and problem definition; Correction planning for problem resolution; and implementation and verification of corrective work. After selection of a plan which the user determines to represent best practicable correction of his PCB contamination problem, the plan can then be developed in a format suitable for submission to the regulatory agencies as the user's Recommended Plan of Corrections for the site. The plan is a proposal which should effect the following actions: Summarize relevant site information; Define existing PCB problems provided; and site conditions; Evaluate alternatives for resolving existing PCB problems; Define recommended corrective actions and their impact; Provide a preliminary plan for implementation; and Solicit regulatory agency acceptance of the plan.

37453 (EPRI-CS/EA/EL—4480, pp 9.17-9.20) **PCB capacitor fire at IREQ's High Voltage Laboratory and subsequent decontamination.** Train, D.; Chamberland, A.; Dupont, D.; Castonguay, J. (IREQ, Varennes, Quebec). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A large power transformer was being tested inside the Annex of IREQ's High Voltage Laboratory. During the tests, an explosion started a fire and caused further explosions within a capacitor bank. An inspection of the interior of the building showed that a fine deposit of soot had settled throughout. Owing to the levels of PCDFs found, the building was considered too contaminated to permit immediate return to normal operation. A major clean-up, repair and decontamination program was organized. The management structure of the cleanup and repair operations is outlined and discussed. Acceptance criteria for reentry to the building were developed, based on those developed for the Binghamton contamination incident. Medical protocols were established to evaluate clinical manifestations of toxicity to PCBs and furans of personnel who either were exposed to smoke during the fire or participated in the decontamination afterwards. Various cleaning methods were employed to decontaminate the building and the thousands of components and pieces of equipment. The effectiveness of the different techniques is discussed. All contaminated residues collected from filters and distillation systems were stored in sealed drums for eventual destruction.

37454 (EPRI-CS/EA/EL—4480, pp 9.21-9.24) **Guidelines and alternatives for PCB soil-sampling programs.** Hansen, W.G.; Johnson, T.L.; Sahatjian, K.A. (Tetra Tech, Inc., Bellevue, WA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Guidance is provided to utilities faced with complex cleanup situations involving PCBs; the discussion is based on a recently completed remedial investigation and feasibility study at a transformer salvage yard in the Pacific Northwest. Definition of sampling program objectives is discussed. In addition to defining the extent of contamination, a sampling program may also include the objectives of detection of related contaminants and identification of hot spots (smaller areas of high concentration in the site's interior) requiring immediate attention or special removal/disposal procedures. The design of the sampling program is also discussed. The proper design of the sampling program is critical to its success and usefulness. A typical sequential design is: Estimate the limits of the site through inspection and accounts of spills and past operations; Select a sampling technique or combination thereof, including sampling at depth, if necessary; and, for stations on a grid system, select a starting point grid size and calculate the number of samples for surface soil sampling. Program cost estimation and quality control considerations are also discussed.

37455 (EPRI-CS/EA/EL—4480, pp 9.25-9.27) **Verification of PCB spill cleanup by sampling and analysis.** Heggem, D.T.; Levy, R.A.; Smith, J.H.; Boomer, B.A.; Erickson, M.D.; Swanson, S.E.; Kelso, G.L.; Turman, J.K.; Cox, D.C.; Schultz, B.D. (Environmental Protection Agency, Washington, DC). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Three reports have been prepared. The first consists of a review and technical evaluation of the available documentation on PCB spill cleanup; it includes preliminary guidelines for the cleanup of PCB spills. The document is intended to provide guidance in all aspects of spill cleanup for those organizations which do not already have working PCB spill cleanup programs. The second report outlines a specific sampling design. It also makes recommendations for sampling and analysis methods to be used to determine compliance with EPA policy on the cleanup of PCB spills. The third report is a field manual which provides detailed, step-by-step instructions on how to complete the field sampling for cleanup verification. A sampling design is proposed for use by EPA enforcement staff in detecting residual PCB contamination above an allowable limit after cleanup of a spill site is completed. Sampling and analysis techniques are recommended for PCB-contaminated solids, water, oils, surface wipes, and vegetation.

37456 (EPRI-CS/EA/EL—4480, pp 9.28-9.36) **Risk assessment developments for PCB/PCDF decontamination projects.** Wade, R.L. (IT Corp., Martinez, CA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Development of site specific risk and exposure assessments can be expensive but the cost is decreasing as these techniques become more routine. The commonly made assumptions for such assessments are becoming more standardized, yet considerable assumptions still occur in the potency factors applied to individual congeners of PCDD's/PCDF's. Likewise, significant variations exists as to the potency of 2,3,7,8- TCDD (0.06-2.0 pg/kg/day) as acceptable intake levels. Increased reliance is being made on risk assessment and the resulting standards that have been developed. Thus, future risk assessment for PCB's, PCDD's, and PCDF's is likely be on hold until further toxicological evidence is developed. Advances in such risk assessment methods will likely be done as the result of critiques of the existing risk assessments. Site specific exposure assessments, however, are powerful tools to be used to modify existing guidelines or to quantitatively evaluate risk of persons either occupationally or incidentally exposed to PCB's, PCDF, PCDD's. 5 references, 4 tables.

37457 (EPRI-CS/EA/EL—4480, pp 9.37-9.39) **Systematic approach to PCB capacitor spill cleanup compliance sampling.** Knight, M.J.; Winship, S.K.; Dmyterko, B.I.; Hemminger, T.E. (Commonwealth Edison Co., Chicago, IL). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

As the requirements for the cleanup of PCB fluid releases from pole-mounted capacitors have become increasingly more stringent, the need for a field sampling protocol accurate enough to demonstrate compliance with those cleanup requirements has become apparent. The goals of a PCB spill site sampling protocol were defined as: Obtain data on PCB dispersal from release events to facilitate response/cleanup activities; Accurately characterize PCB levels remaining at a cleaned spill site; and, Provide evidence to rigorously demonstrate that a spill site has been adequately cleaned and is in compliance with appropriate cleanup standards. It was determined that a sampling system in which samples are located 5 ft. apart could be used to adequately characterize PCB levels in lightly and heavily contaminated areas. Sampling is conducted such that the grid will encompass all areas of known contamination and at least five feet beyond that area on all sides. This sampling approach has as its foundation the concept that PCB dispersion is a non-predictable process.

37458 (EPRI-CS/EA/EL—4480, pp 9.40-9.42) **Commonwealth Edison Company's PCB spill cleanup procedures.** Dmyterko, B.I.; Knight, M.J.; Winship, S.K.; Hemminger, T.E. (Commonwealth Edison Co., Chicago, IL). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Commonwealth Edison Company has developed cleanup procedures to meet the following corporate and environmental goals: Prevent the spread of PCB contamination; Notify affected customers and the public that a spill has occurred, and restrict their access to the affected area; Notify and cooperate with all regulatory agencies in whose jurisdiction the release occurs; Perform the actual physical PCB removal and site cleanup in as rapid and effective manner as possible; Confirm the effectiveness of the cleanup through well-planned sampling and analysis; Restore the site to its previous condition; and, Accomplish the above objectives in a cost-effective manner.

37459 (EPRI-CS/EA/EL—4480, pp 9.43-9.45) **Commonwealth Edison Company's transformer spill response preparedness.** Dmyterko, B.I.; Knight, M.J.; Winship, S.K.; Hemminger, T.E. (Commonwealth Edison Co., Chicago, IL). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The Commonwealth Edison Company has determined that it is necessary to maintain a trained team of company personnel to respond as quickly as possible once a PCB release has occurred, provide on-the-scene direction to company personnel responsible for spill containment and cleanup, collect samples to verify cleanup success and compliance with cleanup standards, interface with customers, property owners and regulatory personnel, provide follow-up control and coordination of PCB release response activities, and restore affected customer or public property to its original condition and use as rapidly as possible.

37460 (EPRI-CS/EA/EL—4480, pp 9.46-9.47) **Analysis of PCB capacitor spill cleanup effectiveness.** Knight, M.J.; Winship, S.K.; Dmyterko, B.I.; Hemminger, T.E. (Commonwealth Edison Co., Chicago, IL). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A detailed analysis of the data generated at 30 spill incidents has been conducted. The results indicate that: The surface-scrubbing techniques and soil removal procedures developed by the Commonwealth Edison Company effectively remove PCBs from impacted areas in a timely manner. It appears that even the most cursory initial cleanup of visibly impacted areas will remove more than 90% of the mass of PCBs released. Two to four cleaning attempts are usually required to meet cleanup standards over the entire site. An overall cleanup efficiency of between 99.84 and 99.998% has been achieved at the sites considered in this analysis.

37461 (EPRI-CS/EA/EL—4480, pp 10.1-10.6) **In situ vitrification of PCB-contaminated soils.** Timmerman, C.L. (Battelle, Pacific Northwest Labs., Richland, WA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

In situ vitrification (ISV) is a patented process developed at PNL for the US DOE as an in-place stabilization technique for radioactive contaminated soils. An engineering-scale in situ vitrification test with PCB-contaminated soil has been successfully performed for the Electric Power Research Institute to determine the fate of PCBs and their by-products when the process is applied. The test provided the following conclusions: The small release of PCBs to the off-gas system can be effectively retained by appropriate design of a conventional treatment system, which utilizes a carbon filter or afterburner. Limited amounts of PCBs were detected in the surrounding soil and none were found in the vitrified block, indicating that the vitrification rate is apparently greater than the PCB diffusion rate in loamy-clay soil and that migration away from the vitrification zone during processing may not be a significant concern. Processing of PCB-contaminated soil by in situ vitrification illustrated a processing destruction and removal efficiency of greater than 99.9% of the process itself, exclusive of off-gas treatment. It is not a panacea, but the process holds promise for application at selected, contaminated soil sites. 4 references, 1 figure.

37462 (EPRI-CS/EA/EL—4480, pp 10.7-10.10) **Human and environmental biodegradation of PCBs.** Brown, J.F. Jr.; Bedard, D.L.; Bopp, L.H.; Carnahan, J.C.; Lawton, R.W.; Unterman, R.D.; Wagner, R.E. (General Electric Research and Development Center, Schenectady, NY). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Thus far, significant degrees of biodegradation have been observed for PCBs in three very different components of aquatic ecosystems, namely, in higher animals, including man; in aerobic bacteria; and in anaerobic sediments. In birds, mammals, and perhaps in some lower animals as well, PCBs are handled like other fat-soluble xenobiotics: small amounts may be eliminated unchanged via the bile or lactation, but most elimination depends upon oxidation to more water-soluble forms. Such oxidations occur mainly in the liver, and are effected by mixed-function oxidase enzymes. In aerobic aquatic ecosystems, and soils as well, the complex microbial populations found include species capable of metabolizing every one of the many chemical constituents of the organic matter naturally present, and also many PCBs. Recently, it has been discovered that PCBs can also be reduced (dechlorinated) in some anaerobic systems, notably the subsurface sediments of the upper Hudson River. At least six chromatographically distinguishable dechlorinating agents, probably corresponding to six different strains of locally prominent anaerobic bacteria, are present in the sediments examined thus far.

37463 (EPRI-CS/EA/EL—4480, pp 10.11-10.26) **Computer aid for compliance with the recordkeeping and reporting requirements of the PCB regulations.** Hedrick, K.D. (Kentucky Utilities Co., Lexington). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Compliance with PCB (40CR761) regulatory requirements has become more manageable for Kentucky Utilities Company since the in-house development and implementation of a computer-aided system for recordkeeping and reporting. The large volume of data that must be collected and manipulated necessitated the computerization of the entire recordkeeping and reporting process. This type of computer application results in better data management and reporting while providing more efficient allocation of resources. The data handling system used has applicability to other utility companies who likewise have access to a mainframe computer. An IBM 4381 VM/SP Rel.4 mainframe computer is the system used at Kentucky Utilities. The recordkeeping and reporting programs operate under a CMS environment and are dependent on the use of CMS EXEC2 and REXX procedures, and XEDIT macros. The software that is utilized are SAS and XMENU, and VS Fortran is the program product used. 10 figures.

37464 (EPRI-CS/EA/EL—4480, pp 10.27-10.30) **Radioactive and non-radioactive polychlorinated biphenyl (PCB) management at Hanford.** Leonard, W.W.; Gretzinger, R.F.; Cox, G.R. (Rockwell International, Richland, WA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Conformance to all state and federal regulations is the goal of Rockwell in the management of both radioactive and non-radioactive PCB's at Hanford. A continuing effort is being made to locate, remove, and properly dispose of all PCB's. As improved methods of management are developed, consideration will be given to them for their adaptation into the Hanford Site PCB Management Plan.

0207 Marketing And Economics

37465 (CONF-8408191—Pt.3) **Uncertainties and innovation - management of northern offshore resources. Pt. 3.** (Offshore Northern Seas -84, Stavanger (Norway)). 1984. 294p. NTIS (US Sales Only), PC A13/MF A01. File Number DE86752309.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

This section of the proceedings contains 15 papers covering the following topics: Political uncertainties; Market and prices; New frontiers: arctic and subarctic areas; Economy and finance; Technical uncertainties and technical innovation. Separate abstracts were prepared for three papers of the section.

37466 (DOE/EIA—0035(86/03)) **Monthly Energy Review, March 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). 27 Jun 1986. 140p. NTIS, PC A07/MF A01; 1 - GPO; GPO Dep. File Number DE86012577.

In addition to current data on production, consumption, stocks, imports, exports, prices for principal energy commodities, a feature article analyzes the contribution of state taxes to US prices of motor gasoline for the 1960 to 1985 period. Adjustments were made for the effects of local taxes and then state taxes were weighted by consumption of motor gasoline in the transportation sector to yield a national average of the state taxes for each year. The authors examine changes in individual states' taxes and in the national average over the 26-year period.

37467 (DOE/EIA—0109(86/04)) **Petroleum Supply Monthly, April 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). 25 Jun 1986. 107p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86012301.

37468 (DOE/EIA—0340(85)/2) **Petroleum supply annual, 1985 Volume 2.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). 13 Jun 1986. 432p. NTIS, PC A19/MF A01; 1 - GPO; GPO Dep. File Number DE86011815.

Volume II contains information on US supply, disposition, and stocks of crude oil and petroleum products for each month of 1985. Contents of this volume include: national statistics; supply and disposition of crude oil and petroleum products by PAD district; production of crude oil (including lease condensates); natural gas processing; refinery operations by PAD district; imports and exports of crude oil and petroleum products; stocks; transportation of crude oil and petroleum products between PAD districts; residual fuel oil by sulfur content; and appendices (district description and maps, and explanatory notes). A glossary is also provided. 28 tabs. (AT)

37469 **Technically recoverable Devonian Shale gas in Ohio, West Virginia, and Kentucky.** Kuuskraa, V.A.; Sedwick, K. (Lewin and Associates Inc.). pp 111-126 of Proceedings of the SPE Eastern regional conference. Richardson, TX; Society of Petroleum Engineers (1985). (CONF-8511139—).

From SPE eastern regional conference; Morgantown, WV, USA (5 Nov 1985).

Large volumes of natural gas may be technically recoverable from the Devonian Shales of Kentucky, Ohio, and West Virginia. The technically recoverable gas from the Huron, Rhinestreet, Cleveland, and Marcellus intervals is estimated to range from 26 Tcf to 82 Tcf, depending on the success of new gas extraction technologies and practices. The total estimated in-place Devonian Shale gas of this tri-state area is 394 Tcf. While much of the resource is in the Huron Shale interval, significant portions are located in other thinner, yet organically rich, shale units that have experienced less development to date. This study represents the most current appraisal of Appalachian Devonian Shale gas potential, and serves as an update of the 1980 National Petroleum Council work for this tri-state area.

0208 Waste Management

37470 (GAO/RCED—86-6) **Air pollution. EPA's strategy to control emissions of benzene and gasoline vapor.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). Dec 1985. 80p. US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877. File Number TI86901390.

Report to the Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives.

This report discusses the Environmental Protection Agency's (EPA's) decision to regulate benzene emissions, including its plans to regulate benzene emitted during automobile refueling. Other factors affecting EPA's decision to regulate benzene emissions from

automobile refueling, including the health effects of gasoline vapor and EPA's ozone standard are also considered.

37471 (STF—21A85028) Composting of oil polluted seaweed. Halmoe, G.; Hoddoe, T. (SINTEF, Trondheim (Norway)). 1985. 18p. (In Norwegian and English). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752127.

The report describes 2 years experience of a rank composting experiment with forced airing from the bottom. Efforts to optimize the degradation of the oil in the waste is made by adding fertilizer and oil absorbing substances. This also affects the mass porosity. During the year about 75% degradation of n-alkanes in a crude oil was obtained. Good growth on the compost was obtained. An article on biodegradation of oil by G. Halmoe, presented at the Oil Spill Conference in Los Angeles the 24th to 28th February 1985 is included as an appendix. 11 tables, 5 drawings.

37472 (STF—21A85043) Treatment of oil containing waste. Experiences with composting and disposal. Halmoe, G. (SINTEF, Trondheim (Norway)). 1985. 19p. (In Norwegian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752128.

For a period of 4 years SINTEF has had several research projects on the composting and disposal of oily waste from beach restoration. The report summarizes biefly the main experiences from these experiments. The treatment methods are compared to other possible methods and recommendations for choice of method regardless of cost for different types of oil containing wastes are made. 2 drawings.

0209 Environmental Aspects

REFER ALSO TO CITATION(S) 37462, 37462, 38088, 38666, 38901, 38941

37473 (EGG—10282-2108) Biological assessment of the effects of petroleum production at maximum efficient rate, Naval Petroleum Reserve No. 1 (Elk Hills), Kern County, California, on the endangered blunt-nosed leopard lizard, Gambelia silus. Kato, T.T.; O'Farrell, T.P. (EG and G Energy Measurements, Inc., Goleta, CA (USA). Santa Barbara Operations). Jun 1986. Contract AC08-83NV10282. 72p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012782.

Surveys to determine the distribution and relative abundance of blunt-nosed leopard lizards on Naval Petroleum Reserve-1 were conducted in 1980 and 1981. In 1982 radiotelemetry and pitfall trapping techniques were used to gain additional information on the species and develop alternative methods of study. Incidental observations of blunt-nosed leopard lizards were recorded and used in the distribution information for NPR-1. DOE determined during this biological assessment that the construction projects and operational activities necessary to achieve and sustain MER have not adversely affected the blunt-nosed leopard lizard and its habitat, because only approximately 6% of the potential blunt-nosed leopard lizard habitat on NPR-1 was disturbed by construction and operational activities. DOE believes that the direct, indirect, and cumulative effects of MER will not jeopardize the continued existence of the species, because results of surveys indicated that blunt-nosed leopard lizards are mainly distributed near the periphery of Elk Hills where few petroleum developments occurred in the past and where they are unlikely to occur in the future. A policy of conducting preconstruction surveys to protect blunt-nosed leopard lizard habitat was initiated, a habitat restoration plan was developed and implemented, and administrative policies to reduce vehicle speeds, contain oil spills, restrict off-road vehicle (ORV) travel, and to prohibit public access, livestock grazing, and agricultural activities were maintained.

37474 (IKU-P—112) Experimental oil spill on Haltenbanken 1982. Audunson, T.; Celius, H.K.; Johansen, O.; Steinbakke, P.; Soerstroem, S.E. (Instituut for Kontinentalsokkelundersoekelser, Trondheim (Norway)). Dec 1984. 106p. NTIS (US Sales Only), PC A06/MF A01. File Number DE86752123.

This experiment aimed at gathering data for the evaluation of existing methods of calculating the drift and spread of oil at sea, as well as possibly finding a basis for the development of improved calculation methods. In addition information was sought about the ecological effects of an oil spill on the open sea. The experiment consisted of a spill of 100 tons of crude oil on Haltenbanken off the coast of Norway, at N 65 degrees 02 minutes, E 07 degrees 33 minutes. The spill and associsted field work was carried out in the period 25 July-1 August 1982. Measurements of concentrations of oil in the water mass were mainly based on in situ information (fluorometry). In addition to giving sufficient information about the dispersion of oil in the water mass, the experiment was clearly a breakthrough for in situ methodology. The most important argument in favor of this methodology is that it gives immediate detailed information concerning the relative values of oil in water. The experiment has given important information for the improvement of exisisting numerical models. The procedures used for calculating the oil budget showed that the evaporation calculations made, provide a sastisfactory approximation of observed conditions. Observations from the exeriment , however, indicated that the dissipation rates employed were too low. The results seem to confirm the hypothesis that the dissipation rate is greater for small spills than large ones. As a result of the experiment on Haltenbanken the work has started on the development of a new complete model for simulating the spread of an oil slick in water. This is a three-dimensional model which can calculate both the horizontal and vertical spread of a slick, as well as the standard direction of drift simulations and budget estimations. 33 references.

37475 (SI-R—84325-1) Computational model for the assessment of oil spill damages. Seip, K.L.; Heiberg, A.B.; Brekke, K.A. (Senter for Industriforskning, Oslo (Norway)). Jun 1985. 129p. NTIS (US Sales Only), PC A07/MF A01. File Number DE86752125.

A description is given of the method and the required data of a model for calculating oil spill damages. Eleven damage attributes are defined: shorelength contaminated, shore restitution time, birds dead, restitution time for three groups of birds, open sea damages-two types, damages to recreation, economy and fisheries. The model has been applied in several cases of oil pollution assessments: in an examination of alternative models for the organization of oil spill combat in Norway, in the assessment of the damages coused by a blowout at Tromsoeflaket and in assessing a possible increase in oil spill preparedness for Svalbard. 56 references.

37476 (SI-R—830709-7) Analysis of the Norway oil spill emergency preparedness- uncertainty, damage reduction, benefit. Main report. Seip, K.L.; Hustoft, A.G.; Ibrekk, H.; Brekke, K.A.; Wenstorp, F. (Sentralinstitutt for Industriell Forskning, Oslo (Norway)). Apr 1985. 20p. (In Norwegian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752122.

An exposition is given of three projects, all treating different aspects of the Norwegian oil spill emergency preparedness: analysis of uncertainty, damage assessment, and the utilitarian value of the damage reducing efforts. The projects represent a further teatment of an earlier project called "Total cost benefit analysis of the Norwegian oil spill emergency preparedness". Jointly the results of the three projects can be used to make a cost benefit analysis of the alternative forms of preparedness. 11 references.

37477 (STF—60A85104) Measurements of oil concentrations with fiberoptical transmittance meters at Haltenbanken June 1985. Nilsen, J.; Darell, L. (Norsk Hydroteknisk Lab., Trondheim). Sep 1985. 26p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752124.

During a field experiment with dispersion of oil on sea in June 1985 at Haltenbanken, off the coast of Norway, measurements were carried out of oil concentrations at one meter depth under the released oil slicks. The measurements were carried out by towing a fiber optical transmittance meter from a boat. The data was registered continuously on both a strip chart and a mini-computer and stored on paper charts and mini-discs. The results of the measurements showed that the oil concentration varied considerably under

each slick. Maximum measured oil concentrations were found to be between 20 and 40 ppM. 3 references.

0210 Legislation And Regulation

37478 **(NP—6752099) First call for tenders. Report from the Danish Ministry of Energy to the energy policy committee of the parliament according to subsection 2 of section 12 in the Underground Act.** (Energiministeriet, Copenhagen (Denmark)). Feb 1983. 83p. (In Danish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752099.

The general terms and policy for exploration and exploitation of hydrocarbons in the Danish underground are reported. The Danish areas to be licensed in this first call for tenders are presented together with the economic terms of operation. Finally the procedures for license application and a draft of the license terms are presented.

0220 Transport, Pipelines, And Handling

REFER ALSO TO CITATION(S) 37405, 38677

37479 **(CONF-8408191—Pt.2) Hydrocarbon transport systems - operation and future development. Pt. 2.** (Offshore Northern Seas -84, Stavanger (Norway)). 1984. 159p. NTIS (US Sales Only), PC A08/MF A01. File Number DE86752138.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

This section of the proceedings contains five papers covering: Developments and design of multiphase pipeline systems; Conventional/unconventional methods of hydrocarbon transportation; Reliability and economics of pipeline operations; Planning of start-up and operation for the Statpipe transport system. Seperate abstracts were prepared for two papers of the section.

37480 (CONF-8408191—Pt.2, pp T1 1-36) **Developments in the simulation and design of multiphase pipeline systems.** 1984. NTIS (US Sales Only), PC A08/MF A01. File Number DE86752138.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

Two-phase pipelines offer the potential for substantial cost savings in the offshore transport of hydrocarbons. Their design has been hampered by uncertainties in two-phase pressure drop relations, in flow regime determination, and in liquid slug length prediction. In order to reduce the uncertainty in two-phase flow pipeline design, Esso, Statoil, Mobil, Texaco and Getty have sponsored the construction of the Norwegian Two-Phase Flow Laboratory in Trondheim, now being operated by SINTEF. A large pipeline-riser experimental facility has been constructed to obtain laboratory quality data in a field scale apparatus. In addition, analytical modeling of two-phase flow is proceeding to provide a framework for interpretation of the experimental measurements. The experimental facility , results of experimental measurements and analytical modeling techniques are described. The two-phase flow data and analysis resulting from this project promise to reduce substantially the uncertainty in the design of two-phase pipelines and downstream separation facilities. 6 references.

37481 (CONF-8408191—Pt.2, pp T3-II 1-43) **Reliability and economics of pipeline operations.** 1984. NTIS (US Sales Only), PC A08/MF A01. File Number DE86752138.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

Several factors are discussed that are important in order to ensure a high capacity utilization and high operational availability of present and future trunk pipelines. Reliable operation of pipelines is essential, as the loss or deferred revenue from a pipeline shutdown may amount to billions of Norwegian kroner. Availability analysis are important tools in cost optimization of new and existing pipeline systems, and necessary data exist for performing these analyses. It is also important to find cost effective ways of tying new users into existing systems without causing excessive shutdowns during the actual tie-in operation or without hazardizing the future reliability of the system. 4 references.

0230 Properties

REFER ALSO TO CITATION(S) 37388

37482 **(AD-A—165998/6/XAB) Reaction intermediates in aromatic-fuel combustion. Final report, 18 July 1984-17 July 1985.** Sanders, W.A. (Catholic Univ. of America, Washington, DC. Dept. of Chemistry). 17 Jul 1985. 36p. NTIS, PC A03/MF A01.

There is increasing tendency in future fuels to have higher aromatic contents because partly of the change in fuel sources (such as coals and shale oils) and partly of the greater use of aromatic compounds as additives due to their high octane values. The chemistry of the oxidation of aromatic compound at combustion temperatures (T > 1500 K) is very complex and poorly understood. This study is part of a series of experiments being carried out to elucidate the oxidation mechanism of C6H6, the most important benchmark system for the aromatic compounds. The unimolecular decomposition of methylphenyl ether (anisole) was studied in incident shock waves covering the temperature range from 1000 to 1580 K and the pressure range from 0.4 to 0.9 atm. The carbon monoxide formed in the reaction, monitored by resonance absorption using a stabilized cw CO laser, could be satisfactorily accounted for by a four-reaction mechanism: C6H5OCH3 yields C6H5O + CH3; C6H5O yields CO + C5H5; CH3 + C6H5O yields o- and p-CH3C6H4OH; and CH3 + CH3 yields C2H6.

0240 Storage

37483 **(SAND—85-1813) Strategic Petroleum Reserve (SPR) creep-closure test on Sulphur Mines cavern 6.** Beasley, R.R.; Wallace, S.T.; Preece, D.S. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1986. Contract AC04-76DP00789. 40p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012608.

This report presents a brief history of Sulphur Mines cavern 6, describes a creep-closure test, and gives the results of the test. At the test conditions from March 1984 through July 1985, the cavern produced an average of 73 barrels of brine per day. Finite element calculations using a laboratory-determined creep model and cavern geometry are compared with the field data. 11 refs., 21 figs., 3 tabs.

37484 **Risk aversion and the insurance value of strategic oil stockpiling.** Toman, M.A.; Macauley, M.K. (Resources for the Future, Washington, DC, USA). *Resources and Energy;* 8: No. 2, 151-165(Jun 1986).

In addition to arbitrage returns, price stabilization from strategic oil stockpiling may provide benefits to risk-averse agents by reducing income riaks induced by fluctuating oil prices. A simple conceptual model of the 'stockpile risk-reduction premia' associated with public and private oil inventories is developed. These premia are shown to depend on private agents' degree of risk aversion, elasticities of oil import demand and supply, and certain covariances involving oil prices. Calculations based on the model suggest that private stockpiling has little risk-reduction value, while the public premium is quite sensitive to the assumptions made about risk preferences and other influences. However, under reasonable assumptions a value of $2-4/bbl appears to be appropriate. These calculations suggest that there is little need for large adjustments to benefit-cost analyses of government oil stockpiling to reflect average social attitudes toward risk. 3 tabs., 32 refs.

37485 **Liquid storage tanks under vertical excitation.** Philippacopoulos, A.J. (Dept. of Nuclear Energy, Structural Analysis Div., Brookhaven National Lab., Upton, New York). pp 107-112 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-7. Fluid structure dynamics. Ma, D.C.; Moody, F.J. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—).

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

Until recently, the hydrodynamic effects on liquid storage tanks induced by an earthquake excitation were basically treated for

the horizontal component of the earthquake. Recent studies, however, showed that the hydrodynamic effects due to the vertical component of an earthquake may be significant. In these studies the tank is assumed to be fixed at the bottom. This paper is concerned with the hydrodynamic behavior of liquid storage tanks induced by vertical earthquake input excitation. First, the fluid-tank system is treated as a fixed-base system and a simple formula is obtained for the coupled fluid-structure natural frequency. Second, additional interaction effects due to the foundation flexibility on the fluid-tank system are investigated. It is concluded that the foundation flexibility may have a significant effect on the hydrodynamic behavior of the liquid storage tanks under a vertical ground shaking.

0250 Combustion

REFER ALSO TO CITATION(S) 37377, 38214

03 NATURAL GAS

0301 Reserves

REFER ALSO TO CITATION(S) 37394

0302 Geology And Exploration

REFER ALSO TO CITATION(S) 37394, 37395, 37403, 37404

37486 (CONF-8408191—Pt.1, pp S7 1-39) **Troll development - the technological challenge.** 1984. NTIS (US Sales Only), PC A09/MF A01. File Number DE86752137.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

Due to the unique combination of difficult circumstances, such as the 340 m water depth, shallow reservoir and great area extent, the development of the Troll hydrocarbon reserves will demand use of new technology on an unprecedented scale. The risks associated with such a bold step are nevertheless clearly recognized, and this paper discusses how the development approach proposed for the Troll field represents a matching of available or minimum- extrapolation technology to the reservoir drainage requirements. A conscious effort has been made to use new technology only in those areas where current techniques, or their extensions, can be shown to be inadequate, and where innovation can be recognized as offering significant cost, safety, technical or operability advantages. A very wide range of solutions has been identified for each of the main technical challenge areas, and a logical and consistent approach has been taken to their evaluation and shortlisting, with particular reference to the inter-relationships and interactions between the individual elements of the total production system. 7 references.

37487 (CONF-8408191—Pt.4, pp G5 1-46) **Frigg field: Production history and seismic response.** Revoy, M. 1984. NTIS (US Sales Only), PC A11/MF A01. File Number DE86752310.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

The Frigg field overlaps the borderline between the UK and the Norwegian continental shelf in the North Sea. The exploration work started in 1965, and the block 25/1 was awarded in 1969. The Frigg field contains natural gas. It was declared commercial in 1972, and the production started in 1977. The Frigg field is the main lobe of a deep sea fan. Several distal lobes have been deposited towards the north, north east and east, and are considered as satellites of the main field. After the discovery, the geophysical activity continued until 1977 with conventional seismic surveys in order to better define the extension of the Frigg field and its satellites. The interpretation of the two main markers related to the sand reservoir, top of reservoir and gas oil contact, did not allow difinitive conclusions to be drawn about the communication between Frigg and its satellites. After 1977 the analysis of the data recorded during three high resolution surveys, has shown the availability of such a technique to provide valuable and accurate seismic information. One purpose with these surveys has been to study the movement of the gas/oil/water interfaces during the production. The last surveys shot between 1979 and 1983 mainly focused on future development and production, and the use of high resolution technique has led to much valuable information, particularly significant in terms of direct hydrocarbons. Despite these new results there are still some uncertainties concerning the evolution of the fluid interfaces and the evolution of the main Frigg and its satellites. 2 references.

37488 (CONF-8408191—Pt.4, pp G6 1-51) **Usage of palynostratigraphy and palynofacies in definition of Troll field geology.** Whitaker, M.F. 1984. NTIS (US Sales Only), PC A11/MF A01. File Number DE86752310.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

The Troll field lies in the western edge of the Norwegian Trench in the North Sea, and encompasses blocks 31/2, 31/3, 31/5 and 31/6. The water depth in the area is 300-350 meters. The Troll field is a giant gas field, containing in block 31/2 alone some 570 billion m^3 gas in place, underlain by a variable oil layer up to 28 m thick. This paper refers to block 31/2 only. Palynological studies, as distinct from sedimentology alone, have made an important contribution to reservoir geological modelling in the Troll field. The geological model described accounts for the nature interrelationship of the various sedimentary units observed in the Troll field appraisal wells, and has been used to predict reservoir sand development and quality in areas remote from well control. Incorporation of core measured permeability data has resulted in the development of a quantitative reservoir quality model, which forms the basis for numerical reservoir simulation studies. 34 references.

0303 Drilling, Production, And Processing

REFER ALSO TO CITATION(S) 37405, 37414, 37433, 37435

37489 (CONF-8404306—, pp 31-57) **Subsea production concepts for the Troll field.** 1984. NTIS (US Sales Only), PC A20/MF A01. File Number DE86752136.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

A range of parameters, which includes the water depth, the soft seabed conditions, the harsh environment, the shallow reservoir and thinness of the oil accumulation combine to make the Troll field hydrocarbon reserves in the North Sea an immense technical challenge. One possible field development alternative consists of a single fixed platform, in 334 m water depth, for the development of the gas, while the development of the oil reservers, located in the western part of the field, will rely entirely on subsea wells. The current indications are that up to 30 subsea producing wells will be required. Four-well and two-well template systems are seen as providing an appropriate response to the reservoir drainage requirements, while single satellite wells are also recognised as having considerable advantages. The application of computer simulation techniques and risk and hazard analyzes to help establish well-founded design premises for these systems in critical areas, such as down hole servicing, template maintenance and protection are discussed, and the indications from preliminary evaluations are given. The underlying philosophy for the design of the necessary subsea facilities is to use existing techniques wherever possible and avoid extrapolating too far from tried and tested solutions. Some technological advances will nevertheless be necessary for an underwater development of this scale and complexity. In particular, the remote connection of flowline bundles in up to 340 m water depth, is seen as a significant technical challenge beyond the current level of proven technology. 8 references.

37490 (PNL-SA—14013) **Development of an expert systems computer program for control panel design enhancement.** Franklin, A.L.; Pelto, P.J.; Fecht, B.A. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 15p. (CONF-860658—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012153.

From Personal computers: gas industry applications; Las Vegas, NV, USA (18 Jun 1986).

The control panel is the principal human/machine interface and is a key system in assuring the safe and reliable operation of a gas industry facility. The majority of gas industry facilities use hardwired control and display systems. Many newer facilities (and some existing facilities) are installing computer-aided control and display systems. In work conducted for the Gas Research Institute, Battelle Northwest has developed human factors guidelines for hardwired (DeSteese et al. 1982) and computer-aided (Fecht et al. 1985) control and display systems. The guidelines themselves represent only a fraction of the total information gained during this research activity. Recent developments in the area of artificial intelligence provide a novel means for transferring and sharing expertise gained in developing these guidelines. A proof of principle expert system has been developed to demonstrate the practicality of using an expert system to record and communicate information traditionally presented in manuals and reports. The nature of expert systems not only provides a convenient means for communicating abstract concepts such as expertise and insight, but it also provides an interactive medium where user access becomes more conversation like. In essence, the manual becomes a mimic of the expert that compiled the information found in the manual. In addition, with an animated or smart manual, the manual itself can become involved in the panel design process by suggesting areas where additional design consideration may be justified. 2 refs.

0304 Products And By-products

37491 **Natural gas in novel processes for fuels and chemical feedstocks.** Steinberg, M. (Process Sciences Div., Dept. of Applied Science, Brookhaven National Lab., Upton, NY). pp 700-701 of Proceedings of condensed papers of the 7th Miami international conference on alternative energy source. Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1986). (CONF-851201—).

From 7. Miami international conference on alternative energy sources; Miami Beach, FL, USA (9 Dec 1985).

It appears that natural gas is almost as abundant as petroleum, if not more so, as a natural resource in many parts of the world. Because of its rich hydrogen content, it is probably the lowest cost source of hydrogen wherever it is available. The most abundant fossil energy resource in the world appears to be coal, and the most abundant renewable resource appears to be biomass (trees and plants), both of which contain a deficiency of hydrogen. It is proposed to use natural gas in conjunction with coal and biomass to produce the physically preferred liquid fuels simulating petroleum products. Processes described include methanolysis which is the direct use of methane for gasification and liquefaction of coal and biomass, and for desulfurization of coal derived liquids and gases. The thermal decompositon of methane is described for hydrogen and carbon particulate production. A cyclical process is described for producing a clean particulate carbon from coal for use in a carbon-water-fuel-mix as a clean substitute diesel fuel or premium-grade boiler fuel. The hydrogen from methane can be used for flash hydropyrolysis processes of coal or biomass or can be used to produce ammonia fertilizer, or can be mixed with natural gas and distributed in the pipelines.

0305 Health And Safety

REFER ALSO TO CITATION(S) 37494, 37495, 37498, 37499

0306 Marketing And Economics

REFER ALSO TO CITATION(S) 37465

37492 (CONF-8408191—Pt.3, pp F2 1-41) **Natural gas for continental Europe. Norwegian gas and implied aspects of energy politics.** Bergmann, B. 1984. NTIS (US Sales Only), PC A13/MF A01. File Number DE86752309.

From Offshore Northern Seas conference; Stavanger, Norway (21 Aug 1984).

Governments and industry in continental Europe largely agree on the objectives of diversification of energy supplies, a minimization of environmental pollution and an optimization of the efficient use of energy. Against this background, gas is a welcome source of energy in the eyes of all governments, which have consequently adopted a policy of not obstructing the progress of gas on the market. Norway is a particularly attractive source of gas. Although no security premium can be attributed to Norwegian gas, this attraction has practical implications, since the gas industry in continental Europe is willing to give Norwegian supplies priority over alternative options, provided such supplies are offered at competetive prices. However, Norway will only be able to profit from this inclination of the West European Market if the country aligns its production and depletion policy to market needs. Otherwise it would be necessary in continental Europe to take hardly reversible decisions opting for alternative sources or a reduction of the share held by gas in the overall energy market. The menace of dumping price offers from the USSR is therefore not the real risk to which Norwegian gas is exported. The crucial element will be the availability of competitive Norwegian gas at the time when additional imports are needed by the market in continental Europe. This need for imports will develop in the first half of the nineties, growing to an annual demand of 45 billion m^3 by the year 2000. For this reason it will be vital for the first phase of the Troll project to be tied into this time frame.

37493 **(DOE/PE—04505-1) Agreement to provide energy planning, analysis, and evaluation.** (Institute of Gas Technology, Chicago, IL (USA)). Mar 1980. 77p. NTIS$9.50.

Three separate subjects are analyzed: (1) the incremental pricing requirements of LNG projects, (2) cooperative Arab/Israeli energy programs based on natural gas, and (3) the effects of the 1978 Natural Gas Policy Act on the country as a whole and particularly on Illinois, Michigan, Wisconsin, and Minnesota. The studies found that (1) incremental pricing of LNG complicates the financing of LNG projects and reduces the number of viable projects, leading to increased oil and LP-gas imports, (2) cooperative gas-utilization ventures between Egypt and Israel should aim at developing a regional pipeline network, constructing export facilities, and producing chemical feedstocks, and (3) the peculiarities of each region of the US, along with the interdependency of the factors involved in assessing the NGPA's impact on each region, complicate any attempt to quantify the act's effects, but the profile constructed for Region 5 will facilitate quantification when more data become available.

0308 Environmental Aspects

REFER ALSO TO CITATION(S) 37503, 38088, 38826

37494 **The effects of large-scale LNG/water RPT explosions.** Mcrae, T.G.; Goldwire, H.C.; Hogan, W.J.; Morgan, D.L. (Liquefied Gaseous Fuels Program, Lawrence Livermore National Lab., Livermore, CA). pp 8 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—). Contract W-7405-ENG-48.

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

When cryogenic liquefied natural gas (LNG) is spilled on water and suddenly heated, one possible result is a kind of "explosive boiling" caused by the rapid phase transition (RPT) from liquid to gas. This "explosive boiling" can generate shock waves much like a conventional chemical explosion, which potentially increases the hazards associated with accidental LNG spills on water. RPT explosions with detonation energy equivalents of several kilograms of TNT occured during large-scale (40-m^3) spill tests of LNG conducted in 1980 and 1981 by the Lawrence Livermore National Laboratory (LLNL). The results of these RPT experiments are presented and discussed in regard to their hazardous effects. The shock wave overpressures are discussed as to their damage effects both above and below the surface of the water. The effect of the RPT explosions was to increase the downwind extent of the flammable region. The impact of this effect on the damage potential of the fire is also discussed.

37495 **Dispersion phenomenology of LNG vapor in the Burro and Coyote LNG spill experiments.** Morgan, D.L. (Liquefied Gaseous Fuels Program, Lawrence Livermore National Lab., Livermore, CA). pp 8 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—). Contract W-7405-ENG-48.

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

Various physical phenomena affecting LNG vapor dispersion were observed in LNG spill experiments conducted by the Lawrence Livermore National Laboratory. Understanding the phenomena is necessary in predicting the size of the hazardous region of vapor concentration following a spill. Gravity flow of the cold dense vapor increased cloud width while density stratification and heat flow from the ground had substantial effects on the mixing rate with air. These phenomena led to a dependence of the maximum distance to the lower flammability limit on source rate, wind speed, and atmospheric stability that was substantially different from the prediction of the Gaussian plume model. Studies employing the numerical SLAB model demonstrate the importance of including these phenomena in predictive models.

0309 Artificial Stimulation

37496 **(PB—86-191111/XAB) Field evaluation of gas-lift and progressive-cavity pumps as effective dewatering methods for coalbed methane wells. Final report, April 1984-December 1985.** Graves, S.L.; Hollingsworth, F.C.; Beavers, W.M. (Methane Research, Inc., Sylacauga, AL (USA)). Mar 1986. 31p. (MRI—86-1). NTIS, PC A03/MF A01.

Field evaluations of gas-lift and progressive-cavity pumps were conducted to determine their effectiveness as dewatering techniques for coalbed-methane wells in the Warrior Coal Field. AMPCO installed a gas-lift system in AMPCO Well No. 6. Problems included poor performance of all gas-lift valve designs and higher instantaneous water production rates than anticipated due to heading and unloading. The test provided the conclusion that gas lift is an effective start-up dewatering tool for initial removal of large amounts of water and solids but that in use as a long-term dewatering tool, needs additional evaluation relative to capital cost, valve design, and extended performance.

37497 **(PB—86-197613/XAB) Hydrologic characterization of coal seams for methane recovery--Activities 3 and 6 progress report: computer program for optimal dewatering for methane production. Topical report, January 1983-December 1984.** Way, S.C.; Bumb, A.C.; Koenig, R.A.; McKee, C.R.; Reverand, J.M. (In-Situ, Inc., Laramie, WY (USA)). Jun 1985. 63p. NTIS, PC A04/MF A01.

The report describes progress on a computer program for automatically determing the optimum number of wells and their best locations for dewatering for methane production under a wide variety of hydrologic conditions. The contractor's existing computer model for designing a dewatering wellfield was modified (1) to maximize total methane released, (2) to exclude specified regions within a property as potential well sites, (3) to include the effects of directional permeability and leakage, (4) to include equations for hydraulic fracturing, and (5) to apply to the unsaturated flow regime which has been identified between single-phase flow of water and true two-phase flow of water and gas.

0310 Legislation And Regulation

REFER ALSO TO CITATION(S) 37478

0320 Transport, Pipelines, And Handling

REFER ALSO TO CITATION(S) 37479, 37480, 37481, 37493, 38677

37498 **(NTSB-PPS—80-1) Analysis of accident data from plastic pipe natural gas distribution systems.** (National Transportation Safety Board, Washington, DC (USA)). 19 Sep 1980. 33p. NTIS$6.50.

To determine whether any significant safety trends are associated with the gas industry's increasing use of plastic (mainly polyethylene) pipe, NTSB analyzed 1975-78 accident data and leak reports and found serious flaws in the data collection program used by NTSB's Materials Transportation Bureau. The data deficiencies prevent the use of normal analysis techniques. The main causes of plastic-pipe leaks were breaks due to external damage, exposure to highly localized heat sources, material failures, and construction defects. In every category, the failure and damage rates for plastic pipe were several times higher than for steel pipe.

37499 **(PB—86-192259/XAB) Costs and benefits of excess-flow valves in gas-distribution services. Final report, March 1984-December 1985.** Atallah, S.; Pape, R. (Risk and Industrial Safety Consultants, Inc., Chicago, IL (USA)). Dec 1985. 142p. NTIS, PC A07/MF A01.

A comparison was made of the costs and benefits (as measured by risk reduction) associated with the use of excess-flow valves on gas-distribution services operating at $>$ or $=$ 10 psig. For the U.S. as a whole, and with conservative assumptions, the cost of installing and maintaining EFVs was found to be inordinately high when compared to the accrued benefits. The expenditure of a total of $8.82 billion ($451 million in 1985 dollars) over the next 50 years would be projected to prevent the occurrence of 6,250 accidents, save a total of 28 lives and 284 injuries and reduce the anticipated property damage by $6.87 million. A sensitivity analysis showed that the average cost per accident prevented was highly dependent on the age at which EFVs were assumed to be replaced and their installation rate. A computer program was provided to allow the calculation of the various costs, the corresponding benefits, and the cost/benefit ratio for individual gas distribution systems.

37500 **Study compares hot-tap welding methods.** Mishler, H.W.; Kiefner, J.F. (Battelle Columbus Labs., OH). *Oil and Gas Journal;* 79: 84-86, 91-93(15 Jun 1981).

The results of Battelle's study of the repair and hot-tap welding practice of various oil and gas companies show that pipeline operators are indeed concerned with making such welding procedures safe; they may even be losing revenues by placing unnecessary restrictions on throughput during hot tapping. The study also identifies factors involved in hot-tap welding that need further research; for example, a rational thermal analysis that accounts for all important variables could predict pipe-material temperature and cooling rates for given heat inputs and product flow and pressure.

0330 Properties

37501 **(PB—86-196185/XAB) Development of an equation of state for computation of supercompressibility factors, critical flow factors, and other properties for wet, sour natural gases, synthetic gases, and admixtures. Annual report, October 1984-September 1985.** Starling, K.E.; Savidge, J.L.; Sadasivan, S.; Reid, T. (Oklahoma Univ., Norman (USA). School of Chemical Engineering and Materials Science). Sep 1985. 120p. NTIS, PC A06/MF A01.

A highly accurate equation of state for sweet/dry natural gases has been extended to include wet and/or sour natural gas systems to meet gas custody-transfer needs. The correlation is applicable over wide ranges of temperature, pressure and composition. For water-sweet natural gas systems, uncertainties are less than 0.1% in the compressibility factor, Z, up to water saturation conditions in the custody transfer region. Uncertainties in the PVT data for H_2S systems make associated equation uncertainties difficult to quantify for sour natural gases. It is felt that for 3% H_2S natural gas mixtures equation uncertainties are on the order of 0.1%. This work has pointed to the need for better sour gas PVT data.

37502 **(PB—86-197647/XAB) Phase equilibria in the carbon dioxide + ethane system. Topical report.** Brown, T.S.; Sloan, E.D.; Kidnay, A.J. (Colorado School of Mines, Golden (USA)). Dec 1985. 72p. NTIS, PC A04/MF A01.

The compositions of natural gases vary substantially, but most U.S. and Canadian gases contain significant amounts of both nitrogen and carbon dioxide in addition to the paraffin hydrocar-

bons. Reliable information on the phase equilibria of carbon dioxide with the hydrocarbon components of natural gas is becoming increasingly important to industry for two reasons. First, the emphasis in the past few years on ethane recovery from natural gas and the use of liquified natural gas peak-shaving facilities by public utilities both require knowledge of the phase equilibria of carbon dioxide systems. Second, the increasing use and cost of natural gas will require future processing of very high carbon dioxide gases that until now were deemed uneconomic for production. There are three objectives to the report: first, to show the results of a literature survey for the carbon dioxide + ethane system; second, to present new, experimental vapor-liquid equilibrium measurements; and third, to discuss the results obtained when the available vapor-liquid equilibria are modeled with a cubic equation of state.

0340 Combustion

REFER ALSO TO CITATION(S) 37494, 38215, 38532, 38665

37503 **Environmental concerns related to natural gas vehicles.** (Energy and Environmental Systems Division, Argonne National Lab., Argonne, IL). pp 375-405 of Nonpetroleum vehicular fuels V:CNG fuel. Singh, M.K.; Moses, D.O. Chicago, IL; Institute of Gas Technology (1985). (CONF-8504127—).

From Non-petroleum vehicular fuels V-CNG conference; Arlington, VA, USA (9 Apr 1985).

Vehicles powered by natural gas are currently used in the United States and other parts of the world. While the number of such vehicles in the U.S. is small, the potential exists for substantial growth. For that reason and because natural gas-fueled vehicles have different performance, emission, and safety characteristics than do gasoline- or diesel-fueled vehicles, a study was conducted at Argonne National Laboratory for the U.S. Department of Energy's Office of Environmental Analysis to document the environmental concerns related to natural gas vehicles. These concerns include those related to vehicle emissions and air quality regulations, safety hazards and regulations, natural gas supply, regulation of natural gas sales, and institutional impacts. This paper reports the results of that study, updated to include the results of several more recent analyses. The paper concludes in particular that while both the safety and emissions records of these vehicles appear satisfactory to data, a comprehensive data base exists in neither area.

37504 **Detailed structure studies of a laminar, methane/air diffusion flame I. Optical Measurements.** Smyth, K.C.; Miller, J.H.; Mallard, W.G.; Santoro, R.J. (Centers for Fire Research and Chemical Engineering, National Bureau of Standards, Gaithersburg, MD 20899). pp 77.1-77.4 of Chemical and physical processes in combustion. Pittsburgh, PA; Combustion Institute (1985). (CONF-841240—).

From 17. Combustion Institute Eastern Section fall technical meeting on chemical and physical processes in combustion; Clearwater Beach, FL, USA (3 Dec 1984).

Several earlier investigations in diffusion flames have reported the detection of intermediate species by laser-induced fluorescence, usually in the visible region. These spectra have been attributed to polycyclic aromatic hydrocarbons (PAH), which have often been proposed as important precursors and perhaps building blocks in models of the chemical steps which lead to soot formation. The present results extend these measurements: profiles of both ultraviolet and visible laser-induced broadband fluorescence have been obtained in a laminar methane/air diffusion flame. Three distinct contributions, all tentatively assigned as PAH fluorescence, are observed. In addition, profiles have been measured for the fluorescence from OH and C_2 radicals and the multiphoton ionization of very small soot particles. The velocity field has been characterized by laser Doppler velocimetry measurements, and temperature profiles have been obtained using thermocouples. The species profile, velocity, and temperature measurements provide a qualitative description of the region of chemical growth leading to particle inception in diffusion flames. When these optical results are combined with the mass spectrometric profiles, the soot nucleation region is found to occur at the high temperature edge of a zone rich in intermediate hydrocarbon pyrolysis products. The formation of intermediate hydrocarbons and subsequent growth of these molecules takes place in a region which closely follows isothermal temperature contours well to the fuel side of the zone of maximum temperature.

04 OIL SHALES AND TAR SANDS

0403 Drilling, Fracturing, And Mining

REFER ALSO TO CITATION(S) 37506

0405 Properties And Composition

37505 **(PB—86-197654/XAB) Thermodynamic characterization of conversion-process oils as materials of continuous distribution. Final report, January 1983-December 1985.** Weil, S.A.; Abbasian-Amin, M.J. (Institute of Gas Technology, Chicago, IL (USA)). Apr 1986. 153p. NTIS, PC A08/MF A01.

The proposed description of a continuous oil considers it as made up of a set of fractional continuous oils. The distribution functions of these fractional oils are appropriately based on the vapor pressure-boiling point-temperature dependence so that the form of the functions are maintained in equilibrium vapor-liquid transformations with explicit transformation rules for the parameters. An application of these concepts to sequential operations has shown that accuracy is maintained very well. From measurements of the equilibrium ratios of a shale oil and of a coal oil in a low-pressure batch distillation system, a readily definable function of the boiling point proved to be a suitable characteristic variable for the proposed description. Also the demonstrated ideality of the system, with respect to liquid-phase composition, is convenient to the proposed description. A limited study of the shale oil in a high-pressure batch-distillation system tends to show similar oil behavior at 500 psig.

0407 Health And Safety

37506 **(PB—86-186111/XAB) Performance characteristics of large-capacity face-ventilation systems for oil-shale mining. Report of Investigations 1986.** Thimons, E.D.; Brechtel, C.E.; Adams, M.E.; Agapito, J.F.T. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center). 1986. 21p. (BM-RI—9006). NTIS, PC A02/MF A01.

The performance of two large-capacity ventilation systems was compared through tests conducted in a large dead-end heading at a pilot oil-shale mine in Colorado. Sulfur hexafluoride tracer gas was used to measure the performance of the two systems: a free-standing jet fan and a reversible fan with rigid duct. The tracer gas was used to simulate the production of mine air pollutants, including blasting pollutants, hot diesel emissions, free methane from surrounding strata, and methane desorbing from muck piles.

0409 Waste Research And Management

REFER ALSO TO CITATION(S) 38941

37507 **GC/MS determination of amines.** Avery, M.J.; Junk, G.A. (U.S.D.O.E. Ames Lab., Ames, IA 50011). pp 819-820 of Proceedings of the 33rd annual conference on mass spectrometry and allied topics. East Lansing, MI; American Society for Mass Spectrometry (1985). (CONF-8505123—).

From ASMS annual conference on mass spectrometry and applied topics; San Diego, CA, USA (26 May 1985).

The sensitivity and selectivity described in this report suggest that the procedure for determining primary amines is generally applicable to environmental waters, waste waters and process streams. The procedure is probably well-suited to biofluids and homogenized tissue where only small sample sizes are normally available. Studies of these applications are currently in progress.

0410 Environmental Aspects

REFER ALSO TO CITATION(S) 38088

05 NUCLEAR FUELS

0502 Exploration

37508 **Uranium in early proterozoic phosphate-rich metasedimentary rocks of east-central Minnesota.** McSwiggen, P.L.; Morey, G.B.; Weiblen, P.W. (Minnesota Geological Survey, 2642 Univ. Avenue, St. Paul, MN 55114). *Economic Geology and the Bulletin of the Society of Economic Geologists;* 81: 173-183(Jan 1986).

Exploration for unconformity-type uranium deposits in the late 1970s in east-central Minnesota led to the discovery of several uranium-bearing phosphorite occurrences in rocks of early Proterozoic age. In this report the authors use the term phosphorite for a rock or specimen that contains substantial sedimentary apatite (Altschuler et al., 1958). The deposits in Minnesota are especially interesting because of their high uranium content but low metamorphic grade. These occurrences characteristically contain 0.025 to 0.085 percent U and locally as much as 0.157 percent U (Ulmer, 1981), whereas typical primary marine phosphorites have uranium contents of 0.005 to 0.02 percent U (Altschuler et al., 1958). The presence of uranium in a marine phosphorite generally is explained by either the replacement of calcium in the apatite crystal structure or the adsorption of uranium in admixed organic matter and cryptocrystalline apatite. In east-central Minnesota the uranium is closely associated with the finely crystalline apatite, but the uranium has also been involved in several episodes of remobilization and redeposition. Thus, even though the phosphorite deposits are an interesting geologic phenomenon in themselves, they also are important as a possible source for epigenetic uranium deposits that may occur in the area.

0505 Enrichment

REFER ALSO TO CITATION(S) 37968

37509 **(K/D—5622-Rev.1) Microcomputer-based instrument for the detection and analysis of precession motion in a gas centrifuge machine. Revision 1.** Paulus, S.S. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). Y-12 Plant). Mar 1986. Contract AC05-84OT21400. 143p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86012615.

The Centrifuge Procession Analyzer (CPA) is a microcomputer-based instrument which detects precession motion in a gas centrifuge machine and calculates the amplitude and frequency of precession. The CPA consists of a printed circuit board which contains signal-conditioning circuitry and a 24-bit counter and an INTEL iSBC 80/24 single/board computer. Pression motion is detected by monitoring a signal generated by a variable reluctance pick-up coil in the top of the centrifuge machine. This signal is called a Fidler signal. The initial Fidler signal triggers a counter which is clocked by a high-precision, 20.000000-MHz, temperature-controlled, crystal oscillator. The contents of the counter are read by the computer and the counter reset after every ten Fidler signals. The speed of the centrifuge machine and the amplitude and frequency of precession are calculated and the results are displayed on a liquid crystal display on the front panel of the CPA. The report contains results from data generated by a Fidler signal simulator and data taken when the centrifuge was operated under three test conditions: (1) nitrogen gas during drive-up, steady state, and drive-down; (2) xenon gas during slip test, steady state, and the addition of gas; and (3) no gas during steady state. The qualitative results were consistent with experience with centrifuge machines using UF_6 in that the amplitude of precession increased and the frequency of precession decreased during drive-up, drive-down and the slip check. The magnitude of the amplitude and frequency of precession were proportional to the molecular weight of the gases in steady state.

37510 **Long-term evaluation of fluoroelastomer O-rings in UF_6.** Russell, R.G.; Otey, M.G.; Dippo, G.L. (Martin Marietta Energy System, Inc., Oak Ridge, Tennessee 37831 and Paducah, Kentucky 42001). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 358-361(May 1986). Contract AC05-84OR21400.

A major component in the gaseous centrifuge enrichment plant (GCEP) was fluoroelastomer O-rings, which were used to seal the uranium hexafluoride (UF_6) gas system. A program utilizing accelerated test conditions was used to help identify the best material out of four selected candidates and to predict the service life of these materials at GCEP conditions. The tests included accelerated temperatures, mechanical stress, and UF_6 exposure. Data were evaluated using the Newman—Keuls[1] ranking system to identify the best material and a zero-order reaction rate equation to help predict service life. This presentation includes a description of the test facility, the materials tested, the types of tests, objectives of the study, service life predictions, and conclusions. The O-rings are predicted to last ~ 30 years, and a high-molecular-weight polymer had the best performance ranking.

0506 By-products

37511 **(AD-A—165790/7/XAB) Production prove-out of a process for remelting depleted-uranium machining chips by vacuum induction. Final report, October 1983-October 1984.** Skillern, C.G.; Vogel, R.L. (Aerojet Ordnance Co., Jonesboro, TN (USA)). Mar 1985. 131p. NTIS, PC A07/MF A01.

An MM & T program to pursue a production prove-out of recycling depleted uranium machining chips in an existing vacuum-induction remelting system was conducted. A viable method of processing DU chips and generating briquettes for remelting was developed. A pilot lot of 80 finished, machined M833 penetrators, fabricated under the guidelines of this program, is available for ballistic testing. Included in this report is a general analysis of facility requirements to implement chip recycling into the Aerojet production cycle.

0507 Fuels Production And Properties

REFER ALSO TO CITATION(S) 37513

0508 Spent Fuels Reprocessing

REFER ALSO TO CITATION(S) 37658

37512 **(ORNL/TM—9833) PRO/Mapper: a plotting program for the DEC PRO/300 personal computers utilizing the MAPPER graphics language.** Wachter, J.W. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 55p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012635.

PRO/Mapper is an application for the Digital Equipment Corporation PRO/300 series of personal computers that facilitates the preparation of visuals such as graphs, charts, and maps in color or black and white. The user prepares an input data file containing English-language commands and writes it into a file using standard editor. PRO/Mapper then reads these files and draws graphs, maps, boxes, and complex line segments onto the computer screen. Axes, curves, and error bars may be plotted in graphical presentations. The commands of PRO/Mapper are a subset of the commands of the more sophisticated MAPPER program written for mainframe computers. The PRO/Mapper commands were chosen primarily for the production of linear graphs. Command files written for the PRO/300 are upward compatible with the Martin Marietta Energy Systems version of MAPPER and can be used to produce publication-quality slides, drawings, and maps on the various output devices of the Oak Ridge National Laboratory mainframe computers.

37513 **(RHO-PB-SR—10-B-CP-MAR.86) Rockwell Hanford Operations. Chemical processing monthly report, March 1986.** (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Mar 1986. Contract AC06-77RL01030. 38p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011795

During the month of March, 208 metric tonnes uranium (MTU's) of zircaloy-clad N-Reactor fuel were charged to the PUREX dissolvers, exceeding the monthly production record of 166 MTU's set in 1984 and bringing the FYTD total to 585 MTU's, 149 MTU's ahead of the 1060 MTU commitment schedule. The PUREX headend improvement process tests, which were initiated in January and February, continued in March. The UO_3 Plant was in a planned maintenance mode during March. Preliminary engineering and design has begun for Aqueous Make-Up (AMU) area engineered barriers to eliminate the potential for release of hazardous chemicals to the environment. The Plutonium Reclamation Facility production campaign was completed, exceeding the annual commitment level by 14%. The nuclear material inventory at the Plutonium Reclamation Facility was successfully completed. The Remote Mechanical C (RMC) maintenance outage work has been accomplished in an excellent manner. Construction on project B-569, RMC Line Fire Suppression System (Halon) (FY 1985 GPP) was completed on schedule and upper budget ($550K vs $630K), in support of the second RMC campaign start. Modifications to enlarge the safeguards and security envelope of the RMC line were completed on schedule in support of the second RMC campaign start. Construction on Room 192A vault upgrade has been completed. The Near-Term Plutonium Finishing Plant (PFP) Liquid Waste Reduction Engineering Study has been completed. The Chemical Processing Long Range Plan (Hanford Chemical Processing Plan) was transmitted to the Department of Energy - Richland Operations office (DOE-RL) and a summary presentation was made to DOE-HQ on March 27.

37514 **Factors influencing the design of the Remote Analytical Laboratory at the Idaho Chemical Processing Plant.** Lewis, L.C.; Dykes, F.W.; Henscheid, J.P.; Wade, M.A.; Ryder, P.I.; Nelson, P.I.; Ostby, D.W.; Gates, M.L.; Jacobson, M.E. (Westinghouse Idaho Nuclear Co., Idaho Falls). *Transactions of the American Nuclear Society;* **50**: 575(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Remote Analytical Laboratory is a special purpose laboratory designed specifically to provide routine analytical chemistry support for the fuel reprocessing operations at the Idaho Chemical Processing Plant near Idaho Falls. It was built to replace the obsolete Remote Analytical Facility, a double line of 30 shielded cubicles equipped with Castle manipulators, which had served the plant since 1953.

37515 **Design and construction of the Remote Analytical Laboratory.** Ostby, D.W.; Nelson, P.I. (Westinghouse Idaho Nuclear Co., Idaho Falls). *Transactions of the American Nuclear Society;* **50**: 575-576(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

During the design and construction of new head-end facilities to dissolve zirconium-clad nuclear fuel at the Idaho Chemical Processing Plant, the existing analytical facilities were determined to be inadequate for providing analytical analysis results necessary to support future operations. New analytical facilities were constructed that combine state-of-the-art analytical technology with systems for remote operation, maintenance, and waste handling.

37516 **Analytical chemistry in a new analytical hot cell facility.** Wade, M.A.; Dykes, F.W.; Goettsche, J.H.; Lewis, A.L.; Lewis, P.C.; Marushia, P.C.; Murphy, J.A.; Reeder, S.D.; Trannell, D.R.; Trejo, L.E. (Westinghouse Idaho Nuclear Co., Idaho Falls). *Transactions of the American Nuclear Society;* **50**: 576-577(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Remote Analytical Laboratory is a new facility at the Idaho Chemical Processing Plant designed to handle samples from the processing of spent nuclear fuel. It consists of a cold laboratory for analyzing process make-up samples, a warm laboratory for analyzing low-level (<100 mR/h) radioactive samples, and a hot cell for analyzing high-level radioactive samples. The hot cell is built in an L shape and contains six work stations, each equipped with a viewing window and two master/slave manipulators. The cell interfaces with a waste handling cell and maintenance area on one end and a glove box complex that interfaces with the warm laboratory on the other end. This paper discusses the remote analytical techniques and equipment developed for use in this facility.

37517 **Remote analytical cell in-cell transfer systems.** Silliker, D.L. (Ralph M. Parsons Co.). *Transactions of the American Nuclear Society;* **50**: 577-578(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The new Remote Analytical Laboratory, located at the Idaho Chemical Processing Plant, required two mechanical transfer systems to handle liquid-filled sample vials within the remote analytical cell. The main transfer system (the in-cell transfer system) would serve the length of the cell along its north side; whereas a similar but shorter system (the optical spectrometer transfer system) would serve the south side of the cell. Selection of applicable equipment was restricted by criteria and led to the adaptation of unusual hardware for a solution. The remote analytical cells' two linear induction motor transfer systems have passed both construction component testing and system operational testing. The transfer systems' controls function very well. Linear induction motor transfer systems can provide a convenient method of remote mechanical transfer in controlled enclosures such as hot cells, pharmaceutical and biochemical process cells, vacuum chambers, and clean cells.

37518 **Remote inductively coupled plasma atomic emission spectrometry.** Stone, R.W.; Dykes, F.W. (Westinghouse Idaho Nuclear Co., Idaho Falls). *Transactions of the American Nuclear Society;* **50**: 578-579(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The technique of inductively coupled plasma atomic emission spectrometry (ICP-AES) offers some distinct advantages in the analysis of radioactive samples. The high sensitivity of the method permits the use of highly diluted sample aliquots, thereby reducing the radioactivity levels involved. The disadvantages of the technique are the complexity of the apparatus required and the difficulty of integrating this apparatus into a hot cell facility. At the Idaho Chemical Processing Plant, a new Remote Analytical Laboratory embodies the described arrangement for remote ICP-AES. Although the installation described is being readied for operation, a mock-up has been in operation for a year. The mock-up has operated so well that it is being used for pilot plant and startup sample analysis. This system is used for the analysis of aluminum, boron, cadmium, iron, tin, uranium, and zirconium with a precision of better than 5%. Experience with the mock-up unit indicates that the torch and the peristaltic pump tubing will last a minimum of 1200 h before replacement is necessary.

0509 Transport And Storage

REFER ALSO TO CITATION(S) 37654, 37656, 37681, 38554, 38555, 38556

37519 **(DOE/DP—0030) Shipment of radioactive materials by the US Department of Energy.** (USDOE Assistant Secretary for Defense Programs, Washington, DC. Transportation Management Div.). 1986. 24p. NTIS, PC A02/MF A01. File Number DE86011729.

This brochure provides notification of, and information on, the general types of radioactive material shipments being transported for or on behalf of DOE in commerce across state and other jurisdictional boundaries. This brochure addresses: packaging and material types, shipment identification, modes of transport/materials shipped, DOE policy for routing and oversize/overweight shipments, DOE policy for notification and cargo security, training,

emergency assistance, compensation for nuclear accidents, safety record, and principal DOE contact.

37520 **(IAEA-SM—286/213) Standard problem exercise to validate criticality codes for large arrays of packages of fissile materials.** Whitesides, G.E.; Stephens, M.E. (Oak Ridge National Lab., TN (USA); Nuclear Energy Agency, 75 - Paris (France). Nuclear Safety Div.). 1986. Contract AC05-84OR21400. 13p. (CONF-860604—25). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011752.

From International symposium on the packaging and transport of radioactive materials (PATRAM '86); Davos, Switzerland (16 Jun 1986).

A study has been conducted by an Office of Economic Cooperation and Development-Committee on the Safety of Nuclear Installations (OECD-CSNI) Working Group that examined computational methods used to compute k/sub eff/ for large ≧5³ arrays of fissile material (in which each unit is a substantial fraction of a critical mass). Five fissile materials that might typically be transported were used in the study. The "packages" used for this exercise were simplified to allow studies unperturbed by the variety of structural materials which would exist in an actual package. The only material present other than the fissile material was a variation in the moderator (water) surrounding the fissile material. Consistent results were obtained from calculations using several computational methods. That is, when the bias demonstrated by each method for actual critical experiments was used to "correct" the results obtained for systems for which there were no experimental data, there was good agreement between the methods. Two major areas of concern were raised by this exercise. First, the lack of experimental data for arrays with size greater than 5³ limits validation for large systems. Second, there is a distinct possibility that the comingling of two shipments of unlike units could result in a reduction of the safety margins. Additional experiments and calculations will be required to satisfactorily resolve the remaining questions regarding the safe transport of large arrays of fissile materials.

37521 **(PNL-SA—13430) Methodology to evaluate the impact of transportation on systems decisions.** McNair, G.W.; Braitman, J.L.; Holter, G.M. (Pacific Northwest Labs., Richland, WA (USA)). Jun 1986. Contract AC06-76RL01830. 12p. (CONF-860604—27). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012151.

From International symposium on the packaging and transport of radioactive materials (PATRAM '86); Davos, Switzerland (16 Jun 1986).

The Pacific Northwest Laboratory, in support of the Department of Energy has developed two models that provide an analytic basis for making key systems decisions that are influenced by transportation. These models are the TRANSIT model; used to provide a first order focus on regions of interest to begin specific site screening activities, and the WASTES model; used to simulate waste systems interactions and provide detailed logistics and economic analyses. This paper will discuss these models and their application to the waste management system.

37522 **(PNL-SA—13810) Wet storage in the USA: recent experience and directions.** Klein, K.; Johnson, A.B. Jr.; Bailey, W.J. (Pacific Northwest Labs., Richland, WA (USA)). Mar 1986. Contract AC06-76RL01830. 15p. (CONF-8605147—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011631.

From IAEA coordinated research program meeting on behavior of spent fuel assemblies in extended storage (BEFAST); Leningrad, USSR (26 May 1986).

Wet storage has been the only licensed option for spent fuel management for US commercial power reactor operators, except for a period of commercial reprocessing at the Nuclear Fuel Services facility, 1965-71. Developments are underway to bring dry storage to licensed status on the US by mid-1986. However, wet storage will remain the predominant storage method, at least beyond the turn of the century. The Nuclear Waste Policy Act of 1982 establishes current US policy regarding responsibilities for spent fuel management. The Nuclear Waste Confidence Rulemaking proceedings address the viability of extended wet storage for US reactors. US utilities have moved aggressively to implement optimized utilization of wet storage technology, assisted in some areas by federal programs. This paper summarizes US policy and regulatory aspects of wet storage and the status of several wet storage technology developments, including: dense racking, double tiering, credit for burnup in rack designs, transshipment, impacts of extended burnup, rod consolidation, and pool decommissioning.

37523 **(SAND—86-0054C) DOE/PNC joint program on transportation technology.** Kubo, M.; Kajitani, M.; Seya, M.; Yoshimura, H.R.; Moya, J.L.; May, R.A.; Huerta, M.; Stenberg, D.R. (Sandia National Labs., Albuquerque, NM (USA); Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan); Southwest Engineering Associates, Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 9p. (IAEA-SM—286/96; CONF-860604—26). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011180.

From International symposium on the packaging and transport of radioactive materials (PATRAM '86); Davos, Switzerland (16 Jun 1986).

This paper summarizes the work performed in a cooperative program on transportation technology between the Department of Energy (DOE) and the Power Reactor and Nuclear Fuel Development Corporation (PNC) of Japan. This work was performed at Sandia National Laboratories (SNL) in Albuquerque, New Mexico. The joint program emphasized the safety analysis for truck transportation of special nuclear materials (SNM) in Japan. Tasks included structural analyses and testing, thermal testing, leak rate studies and tests, and transportation risk assessments. The purpose of this paper is to present the results of full-scale structural and thermal tests conducted on a PNC development SNM transport system. Correlation of full-scale impact test results with structural analysis and scale model testing will also be reviewed.

37524 **(SAND—86-1295C) Estimated annual worldwide shipments of radioactive material.** Pope, R.B.; McClure, J.D. (Sandia National Labs., Albuquerque, NM (USA); International Atomic Energy Agency, Vienna (Austria)). 1986. Contract AC04-76DP00789. 10p. (IAEA-SM—286/6; CONF-860604—24). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011646.

From International symposium on the packaging and transport of radioactive materials (PATRAM '86); Davos, Switzerland (16 Jun 1986).

Data on shipments within or from 35 Member States of the IAEA have been used to estimate the volume of shipping radioactive materials worldwide. The data have been extrapolated demographically, and it is estimated that from 18 to 38 million package shipments were made annually in the early 1980's.

37525 **(SAND—86-7083) Railroad transportation of spent nuclear fuel.** Wooden, D.G. (Wooden (Donald G.), St. Albans, VT (USA)). Mar 1986. Contract AC04-76DP00789. 113p. (TTC—0574). NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86011594.

This report documents a detailed analysis of rail operations that are important for assessing the risk of transporting high-level nuclear waste. The major emphasis of the discussion is towards "general freight" shipments of radioactive material. The purpose of this document is to provide a basis for selecting models and parameters that are appropriate for assessing the risk of rail transportation of nuclear waste.

37526 **Experimental and numerical comparisons of low-speed impact and punching of woven Aramid panels.** Glass, R.E.; Duffey, T.A.; Adler, W.F. (Sandia National Laboratories). pp 37-42 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-6. Structural dynamics. Chen, S.S. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—). Contract AC04-76DP00789.

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

Vessels used to transport radioactive materials must be protected against low-speed puncture-type loadings. One promising puncture protection scheme involves the use of puncture panels incorporating woven Aramid fabric. An experimental and numerical

investigation on the response of punch-loaded, woven Aramid fabric protection panels, was undertaken. Initially, individual yarn tests at quasi-static and low-speed dynamic strain rates were performed for material property determination, followed by quasi-static and low-speed dynamic punch tests on clamped, woven Aramid panels (single- and multiple-layer). Comparisons of experimental results with both refined and simplified calculational models showed reasonable agreement for force-deflection history of the punch fabric. The simplified finite element model was found to be useful in economically analyzing multiple woven fabric layers subjected to concentrated loading.

0510 Marketing And Economics

37527 **Monitoring the viability of the U.S. uranium industry: a suggested approach.** Curlee, T.R. (Economic Analysis Section, Energy Division, Oak Ridge National Laboratory, Oak Ridge, TN). *Energy Systems and Policy;* 9: No. 3, 303-325(1985).

Recent trends in the U.S. and world uranium markets have generated concern about the viability of the U.S. uranium industry. In response to this concern legislation has been passed that requires the U.S. Department of Energy to assess the viability of the domestic uranium industry on a yearly basis through the year 1992. However, the criteria by which the viability of the industry is to be assessed are subject to debate. This paper discusses the reasons for concern about uranium viability and suggests an approach to be used in monitoring the viability of the industry. A distinction is made between monitoring viability from two broad and possibly conflicting perspectives--economic efficiency and distributive equity. In suggesting specific viability criteria, the similarities between uranium viability and oil vulnerability are drawn.

0520 Waste Management

REFER ALSO TO CITATION(S) 37637, 37640, 37642, 37643, 37644, 37645, 37648, 37649, 37651, 37653, 37657, 37659, 37660, 37661, 37662, 37663, 37664, 37667, 37668, 37669, 37677, 38356, 38401, 38402, 38410, 38413, 38471, 38526, 38787, 38913, 38914, 38984, 38990, 38998, 38999, 39000, 39001, 39004, 39005, 39006, 39007, 39012, 39013, 39014, 39015

37528 **(BMI/ONWI—600) Salt repository sealing materials development program: 5-year work plan.** Myers, L.B. (Battelle Memorial Inst., Columbus, OH (USA). Office of Nuclear Waste Isolation). Jun 1986. Contract AC02-83CH10140. 44p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012838.

This plan covers 5 years (fiscal years 1986 through 1990) of work in the repository sealing materials program to support design decisions and licensing activities for a salt repository. The plan covers a development activity, not a research activity. There are firm deliverables as the end points of each part of the work. The major deliverables are: development plans for code development and materials testing; seal system components models; seal system performance specifications; seal materials specifications; and seal materials properties "handbook." The work described in this plan is divided into three general tasks as follows: mathematical modeling; materials studies (salt, cementitious materials, and earthen materials); and large-scale testing. Each of the sections presents an overview, status, planned activities, and summary of program milestones. This plan will be the starting point for preparing the development plans described above, but is subject to change if preparation of the work plan indicates that a different approach or sequence is preferable to achieve the ultimate goal, i.e., support of design and licensing.

37529 (CONF-8509121—, pp 5-8) **Challenges for future low-level waste management.** Smiley, J.L. (Dept. of Energy, Washington, DC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The two main challenges for future low-level waste management discussed by the author include decision making and licensing. Neither responsibility nor visibility concerning low-level radioactive waste disposal ends at the fence that separates DOE facilities and operations from the outside world. DOE must now evaluate alternatives and decide how it will develop and implement treatment methods and disposal systems that provide improvements to the practices that are employed.

37530 (CONF-8509121—, pp 9-21) **Considerations of Department of Energy low-level waste management programs.** Barainca, M.J. (Dept. of Energy, Idaho Falls, ID). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

This paper presents an overview of the activities of the Department of Energy's (DOE) Low-Level Radioactive Waste Management Programs (LLWMP) progress in the last year. Plans for the near future under both the Defense and Nuclear Energy LLWMP are discussed. Highlights of recent coordination activities between the DOE Programs, Nuclear Regulatory Commission (NRC), Environmental Protection Agency (EPA), private industry, and several states are presented. DOE Programs are being influenced by several external factors, i.e., state regulations, public perception. These factors are determining the course that low-level waste management (LLWM) must take and the specific issues that research and development programs must address. Greater emphasis is therefore being placed on quantifying the uncertainties and validating assumptions and theories associated with the performance of low-level waste disposal technology. Simultaneously, existing technology must be applied to more fully control the disposal environment. Such applications may provide a greater degree of protection for the environment, thereby allowing greater public acceptance and more rapid development of new disposal facilities. As in the past, the objective of this meeting is to present an opportunity for discussions between the researchers and potential users of the technology. This should enable the researchers to better understand the needs of the users and address the concerns leading to application of technology. 12 figures, 1 table.

37531 (CONF-8509121—, pp 41-45) **Challenges of new low-level radioactive waste facility development.** Avant, R.V. Jr. (Texas Low-Level Radioactive Waste Disposal Authority). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The siting of new low-level radioactive waste disposal facilities is the current concern of states and compacts. Facility development is the next major effort that must be faced after a site has been selected and characterized. It involves facility design, preparation of operating procedures, licensing, and construction. New technologies, revised laws and regulations, changing management approaches, and public interests all impact and must be considered in facility development. This paper identifies and discusses the next set of challenges developers of low-level radioactive waste disposal facilities will be facing. The problems of facility development could be even more technically and politically complex than site selection.

37532 (CONF-8509121—, pp 46-49) **DOE low-level waste management - an evolving system.** Dieckhoner, J.E. (Dept. of Energy, Washington, DC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

This presentation will discuss the historic and continuing evolutionary nature of the low-level waste management system from the perspective of the Department of Energy's operations. It will briefly review this evolution from its inception to the present day, and then attempt to project where it is heading. The shift in emphasis to the concept of a total waste management system, rather than just waste disposal alone, will be discussed. This presentation will alert operators to the evolving nature of this system and similarly alert researchers to the issues facing the operators, and to which they should be addressing their efforts.

37533 (CONF-8509121—, pp 50-62) **Technology application of enhanced engineered disposal.** Jicha, J.J. Jr. (Dept. of Energy, Washington, DC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

This presentation will review the technology developed for consideration at DOE operating sites which would provide cost-effective solutions for low-level waste disposal in the near surface. The presentation will review treatment processes (glass furnace, waste incineration and encapsulation, etc. as well as engineered barriers, etc.). This presentation will give an overall perspective of the emphasis and potential policy implications for future application of these technologies in order to meet disposal requirements for problem wastes and/or sites which may be difficult to adequately characterize. This presentation challenges researchers to address issues before technologies are chosen and used by operators.

37534 (CONF-8509121—, pp 65-78) **Recent developments in the management of low-level radioactive wastes around the world.** Lakey, L.T. (Pacific Northwest Lab., Richland, WA). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The criteria and technology for the management of low-level radioactive wastes have largely been established. Conventional engineered processes are commonly used to treat the wastes while fixation, if employed, uses cement or bitumen. Indefinite storage in surface facilities or burial in shallow land sites are commonly used for disposal. The definition of waste categories varies from country to country, but all waste generators design and operate their waste facilities to hold human exposures and environmental releases within internationally accepted guidelines. Recent interest has been directed at achieving a consensus on a de minimis risk level. New and improved facilities continue to be put into operation both for treatment and disposal of low-level wastes. Notable examples are the use of supercompactors in the Netherlands and West Germany and the engineered surface storage facilities used by the French. The international agencies, IAEA, OECD/NEA, and CEC, have also been active in promoting improvements in management of low-level wastes.

37535 (CONF-8509121—, pp 79-83) **Low-level radioactive waste management in France.** Hutchinson, C.; Marque, Y. Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The safe disposal of low-level radioactive waste in France is achieved by adhering to an integrated waste management system that addresses each aspect of waste production, stabilization and disposal. The central feature of the system is its comprehensive quality assurance and control plan. The system is described and its application to waste disposal activities in France is illustrated.

37536 (CONF-8509121—, pp 84-92) **UK management of low-level radioactive wastes.** Richards, M.J. (United Kingdom Dept. of the Environment). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The current policy of the UK government on the management of radioactive wastes remains as set out in the 1982 White Paper and confirmed in a document submitted to the Sizewell public inquiry. Responsibilities for the national strategy lies with the Environment Departments, but the organizations which produce radioactive wastes are responsible for ensuring the safe and effective management of such wastes, and for meeting the costs of necessary action, in accordance with the polluter pays principle. Authorization to discharge or dispose of radioactive waste is given by the Authorizing Departments and a license for operations at a disposal facility by the Health and Safety Executive. Technical considerations favor early disposal for low-level wastes, for delay provides no advantage and lengthy R and D is not required into methods of disposal. Very low-level wastes can be safely disposed with ordinary household refuse, or in liquid or gaseous form. The low-level wastes are also normally disposed of because adequate facilities have been available in controlled landfill sites or to the sea. Wastes that would have gone for sea disposal are at present being stored at nuclear sites while reviews of the scientific case for sea disposal are being completed. New facilities will be developed and operated by the Nuclear Industry Radioactive Waste Executive on behalf of the main waste producers. Systematic monitoring of radioactivity in the environment is carried out, particularly with reference to possible pathways to man.

37537 (CONF-8509121—, pp 95-109) **Engineered sorbent barrier screening studies.** Freeman, H.D.; Buelt, J.L. (Pacific Northwest Lab., Richland, WA). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC06-76RLO1830.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The objective of the Engineered Sorbent Barrier Program is to identify new and cost-effective technology for restricting the migration of radionuclides from low-level waste sites. The primary emphasis is to identify and evaluate sorbent materials as engineered barriers that will prevent radionuclide migration and yet allow moisture to pass. Screening studies have been completed to identify sorbent materials for cesium, cobalt, and strontium. The sorbent materials were selected based on criteria developed for this program and the empirical results of screening studies. The results of the study made it apparent that no single sorbent material is effective for all radionuclides considered. Therefore, four composite sorbent barriers were identified for further evaluation in 0.6-m diameter columns. The large columns more accurately represent field conditions, generate permeability data, and enhance detectability of radionuclides in the leachate passing through the sorbent barriers. The four sorbent barriers include composites of activated charcoal, greensand, A-51 zeolite, and red pottery clay. Future studies will concentrate on completing the effectiveness evaluation with the large columns and identifying a more cost-effective sorbent material for strontium. 6 references, 4 figures, 4 tables.

37538 (CONF-8509121—, pp 110-121) **Waste migration studies at the Savannah River Plant burial ground.** Stone, J.A.; Oblath, S.B.; Hawkins, R.H.; Grant, M.W.; Hoeffner, S.L.; King, C.M. (E.I. du Pont de Nemours and Co., Aiken, SC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC09-76SR00001.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The low-level radioactive waste burial ground at the Savannah River Plant is a typical shallow-land-burial disposal site in a humid region. Studies of waste migration at this site provide generic data for designing other disposal facilities. A program of field, laboratory, and modeling studies for the SRP burial ground has been conducted for several years. Recent results of lysimeter tests, soil-water chemistry studies, and transport modeling are reported. The lysimeter experiments include ongoing tests with 40 lysimeters containing a variety of defense wastes, and recently concluded lysimeter tests with tritium and plutonium waste forms. The tritium lysimeter operated 12 years. In chemistry studies, measurements of soil-water distribution coefficients (K/sub d/) were concluded. Current emphasis is on identification of trace organic compounds in groundwater from the burial site. Development of the dose-to-man model was completed, and the computer code is available for routine use. 2 figures, 2 tables.

37539 (CONF-8509121—, pp 122-139) **Control of water infiltration through SLB trench covers.** Schulz, R.K.; Ridky, R.W. (Univ. of California, Berkeley). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

A technique for control of water infiltration into waste burial trenches is described. Initial results show the procedure to be very promising. In essence, the technique combines engineered or positive control of run-off, along with a vegetative cover, and is named bioengineering management. To investigate control of infiltration, lysimeters are being used to make complete water balance measurements. The studies are underway at the Maxey Flats, Ken-

tucky, low-level waste burial site. Where the original Maxey Flats site closure procedure is followed, it is necessary to pump large amounts of water out of the lysimeters to prevent the water table from rising closer than 2 meters from the surface. Using the fescue grass bioengineering management procedure, no pumping is required. Encouraged by the initial findings in the rather small-scale lysimeters, a large scale demonstration of the bioengineering management technique has been initiated in Beltsville, Maryland. 6 references, 14 figures.

37540 (CONF-8509121—, pp 140-155) **Data acquisition system for geophysical diffraction tomography.** Witten, A.J.; Stevens, S.S.; Rosenberg, S. (Oak Ridge National Lab., TN). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Geophysical diffraction tomography is an emerging technique that shows promise as a tool for quantitative, high-resolution subsurface imaging. The technique possesses similarities to both X-ray CAT scanners and conventional geophysical seismic profiling. The imaging approach employed in diffraction tomography is a generalization of that used in CAT scanners to account for the diffraction (ray bending) which occurs in the propagation of the longer wavelength acoustic energy. While CAT scanners are devices that rotate about the region to be imaged, geophysical tomography is necessarily limited to fixed instrument configurations such as those employed in geophysical seismic profiling. The geophysical diffraction tomography effort has focused on reducing this technique to practice. This paper presents an overview of the current status of this effort including sample reconstructions obtained through numerical experiments, a description of the hardware, and examples of data collected in the field. Specific emphasis is given to the instrumentation since this represents a significant advance in the state-of-the-art of geophysical data collection and processing. The power of this system is demonstrated by an example of an actual subsurface image obtained in the field. 4 references, 9 figures.

37541 (CONF-8509121—, pp 156-175) **Development of technology for the design of shallow land burial facilities at arid sites.** Nyhan, J.W.; Abeele, W.V.; Drennon, B.J.; Herrera, W.J.; Lopez, E.A.; Langhorst, G.J.; Stallings, E.A.; Walker, R.D.; Martinez, J.L. (Los Alamos National Lab., NM). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Los Alamos field research program involving technology development for arid shallow land burial sites is described. Field data are presented for an integrated field experiment, which was designed to test individual SLB component experiments related to erosion control, biobarriers, and subsurface capillary and migration barriers. Field tests of biointrusion barriers at waste disposal sites and in experimental plots are reported. The results of a joint DOE/NRC experiment to evaluate leaching and transport of sorbing (Cs, Sr, Li) and nonsorbing (I, Br) solutes in sand silt backfill are presented for steady-state and unsteady-state flow conditions. A capillary barrier experiment performed in a large caisson (3-m diameter, 6.1 m deep) is described and a year's worth of field data is presented. 8 references, 13 figures.

37542 (CONF-8509121—, pp 176-196) **Design, siting, criteria and cost analysis for a small low-level waste disposal facility.** Lavallee, F. (Maine Dept. of Environmental Protection). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The paper summarizes an investigation of shallow land burial (SLB) made by the Maine Department of Environmental Protection (DEP) under a 1984 Department of Energy (DOE) grant. It further presents a recently completed design, costing exercise and economic analysis of an engineered disposal facility, prepared by DEP as an alternative to SLB disposal. Maine's humid climate and high permanent water table, combined with its heterogeneous surficial geology were seen to pose significant problems to conventional SLB. The initial report presented Maine's proposed site selection process and modifications to SLB, intended to overcome limitations of climate and geology. Unit disposal costs were projected for facilities that would accommodate various combinations of Maine, New Hampshire and Vermont LLW volumes. Several scenarios were also developed to accommodate wastes from the decommissionings of the region's atomic power generation facilities. The recent follow-up study investigated the design and economics of an earth-mounded bunker as an alternative to SLB. A hybrid facility was proposed which combined the aboveground tumulus of the Centre de la Manche, France with the Westinghouse/Hittman SUREPAK concept of waste form stability. Facilities were designed to accommodate Maine's LLW volume, with and without decommissioning waste. As with the SLB study, only part-time facility operation was assumed. Costs were developed for all life-cycle phases. Unit disposal costs were projected using the EG & G economic model, LLWECON.

37543 (CONF-8509121—, pp 197-209) **Low level waste data base development - EPICOR-II resin/liner investigation - a program review.** McConnell, J.W. Jr. (Idaho National Engineering Lab., Idaho Falls). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

This paper presents an overview of the titled program and gives the status of the work on resin degradation, resin solidification, and field testing of solidified samples. A brief discussion of some recent results is also included. Resin materials from EPICOR-II prefilters used in the cleanup of the Three Mile Island Nuclear Power Station are being examined to (a) develop a low level waste data base and (b) obtain information on survivability of waste forms composed of ion exchange media loaded with radionuclides and solidified in matrices of cement and Dow polymer. An unusual aspect of this investigation is the use of commercial grade resins which have been loaded with over five times the radioactivity normally seen in a commercial application. That dramatically increases the total radiation dose to the resins.

37544 (CONF-8509121—, pp 213-225) **Development of an accelerated leach test(s) for low-level waste forms.** Dougherty, D.R.; Fuhrmann, M.; Colombo, P. (Brookhaven National Lab., Upton, NY). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

An accelerated leach test(s) is being developed to predict long-term leaching behavior of low-level radioactive waste (LLW) forms in their disposal environments. As necessary background, a literature survey of reported leaching mechanisms, available mathematical models and factors that affect leaching of LLW forms has been compiled. Mechanisms which have been identified include diffusion, dissolution, ion exchange, corrosion and surface effects. A computerized data base of LLW leaching data and mathematical models is being developed. The data is being used for model evaluation by curve fitting and statistical analysis according to standard procedures of statistical quality control. Long-term leach tests on portland cement, bitumen and vinyl ester-styrene (VES) polymer waste forms are underway which are designed to identify and evaluate factors that accelerate leaching without changing the mechanisms. Initial results on the effect of temperature on leachability indicate that the leach rates of cement and VES waste forms increase with increasing temperature, whereas, the leach rate of bitumen is little affected.

37545 (CONF-8509121—, pp 226-238) **Nitrate waste processing by means of the joule-heated glass furnace.** Armstrong, K.M.; Klingler, L.M. (Monsanto Research Corp. Mound, Miamisburg, OH). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC04-76DP00053.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

An investigation was conducted to determine the feasibility of using a joule-heated glass furnace to treat the low-level radioactive nitrate salt wastes being generated in vast quantities at a number of DOE sites. Under current disposal practices, these salts,

because of their high solubility, pose a serious threat of groundwater contamination. The goal of the project was to demonstrate thermal decomposition of the salts, without creating an alternate environmental problem by releasing nitrogen oxide gases to the atmosphere. Through the use of literature searches and a series of experimental runs it was found to be possible to obtain both high percentage salt destruction and simple and inexpensive NO/sub x/ control. The selective reduction agent, ammonia, introduced under proper furnace conditions, controlled NO/sub x/ emissions to well under 500 ppm without any equipment modifications. 4 figures, 5 tables.

37546 (CONF-8509121—, pp 239-253) **Testing and evaluation of polyethylene and sulfur cement waste forms.** Franz, E.M.; Kalb, P.D.; Colombo, P. (Brookhaven National Lab., Upton, NY). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

This paper discusses the results of recent studies related to the use of polyethylene and modified sulfur cement as new binder materials for the improved solidification of low-level wastes. Waste streams selected for this study include those which result from advanced volume reduction technologies (dry evaporator concentrate salts and incinerator ash) and those that remain problematic for solidification using contemporary agents (ion exchange resins). Maximum waste loadings were determined for each waste type. Recommended waste loadings of 70 wt% sodium sulfate, 50 wt% boric acid, 40 wt% incinerator ash and 30 wt% ion exchange resins, which are based on process control and waste form performance considerations are reported for polyethylene. For sulfur cement the recommended waste loadings of 40 wt% sodium sulfate and boric acid salts and 43 wt% incinerator ash are reported. However, incorporation of ion exchange resin waste in modified sulfur cement is not recommended due to poor waste form performance. Data is presented that can be used to assess the acceptability of polyethylene and modified sulfur cement waste forms to meet the requirements of 10 CFR 61. 8 references, 10 figures, 6 tables.

37547 (CONF-8509121—, pp 254-257) **Development and testing of a mobile incinerator.** Eggett, D.R. (Commonwealth Edison). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The development and testing of a mobile incinerator for processing of combustible dry active waste (DAW) and contaminated oil generated at Nuclear Power Plants is presented. Topics of discussion include initial thoughts on incineration as applied to nuclear waste; DOE's Aerojet's, and CECo's role in the Project; design engineering concepts; site engineering support; licensability; generation of test data; required reports of the NRC and Illinois and California EPA's; present project schedule for incinerating DAW at Dresden and other CECo Stations; and lessons learned from the project.

37548 (CONF-8509121—, pp 258-266) **Low-level nitrate waste process development.** Arnold, P.M.; Johnson, A.J. (Rockwell International Corp., Golden, CO). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

A denitrification technology development program has been conducted for four years at the Rocky Flats Plant and has identified several promising denitrification methods. DOE sites were first surveyed to determine nitrate waste generation rates, inventory and regulatory concern. The need for processes to handle this waste category was evident, both from the survey results and comments of site operators. The denitrification methods identified are classified as thermal, aqueous and biological. Thermal processes were demonstrated to destroy the nitrates with the creation of less than 500 ppm NO/sub x/ as a by-product. Studies were performed on a molten salt destructor, high temperature fluid wall (HTFW) reactor, and also by Mound using their glass furnace. A preliminary design and cost estimate report has been prepared for a one million kilogram per year process for denitrification using the HTFW reactor. An aqueous process consisting of formic acid and sulfuric acid reflux was developed which converts the nitrate to other forms, but results in slightly elevated NO/sub x/ emissions. Biodenitrification was developed at Oak Ridge and is in production use there. Results and conclusions on the program are discussed.

37549 (CONF-8509121—, pp 267-276) **Evaluation and performance of the special wasteform lysimeters at a humid site.** Oblath, S.B.; Hoeffner, S.L. (E.I. du Pont de Nemours and Co., Aiken, SC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC09-76SR00001.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Savannah River Laboratory has been evaluating the leaching/migration behavior of commercial power reactor wasteforms by the use of lysimeters operated under field conditions at a humid site. These lysimeters model the conditions in actual burial trenches. Wasteforms comprising Portland cement, masonry cement, and vinyl ester-styrene polymer wasteforms were emplaced in the lysimeters in March 1982. Effluent water has been analyzed on a regular basis since that time. Cs-137, Sr-90, and/or Co-60 have been observed in the effluent water from the lysimeters, as well as in soil moisture samples collected from the unsaturated zone beneath the wasteforms. In March of 1984, horizontal cores were taken from one of the lysimeters containing a Portland cement wasteform to determine the vertical and radial profiles of radionuclides which might not have reached the lysimeter sump. Results from all of these sampling methods are discussed and interpreted.

37550 (CONF-8509121—, pp 277-286) **Special Waste Form Lysimeters-Arid: annual report 1985.** Walter, M.B.; Graham, M.J. (Pacific Northwest Lab., Richland, WA). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC06-76RL01830.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Special Waste Form Lysimeters-Arid program was initiated to determine typical source terms generated by commercial solidified low-level nuclear waste in an arid climate. Waste-form leaching tests are being conducted at a field facility at the Hanford site near Richland, Washington. A similar program is being conducted at a humid site. The field facility consists of 10 lysimeters placed around a central instrument caisson. The waste samples from boiling water and pressurized water reactors were emplaced in 1984, and the lysimeters are being monitored for movement of contaminants and water. Solidifying agents being tested include vinyl ester-styrene, bitumen, and cement. Laboratory leaching and geochemical modeling studies are being conducted to predict expected leach rates at the field site and to aid field-data interpretation. Small samples of the solidified waste forms were made for use in the laboratory leaching studies that include standard leach tests and leaching of solidified waste forms in soil columns. Complete chemical and radionuclide analyses are being conducted on the solid and liquid portions of the wastes.

37551 (CONF-8509121—, pp 289-301) **Leaching studies of low-level radioactive waste forms.** Dayal, R.; Arora, H.; Clinton, J.C.; Milian, L. (Brookhaven National Lab., Upton, NY). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

A research program has been under way at the Brookhaven National Laboratory to investigate the radionuclide release behavior of ion exchange bead resin waste solidified in Portland cement. An important aspect of this program is to develop and evaluate testing procedures and methodologies which enable the long-term performance evaluation of waste forms under simulated field conditions. Cesium 137 and strontium 85 release behavior using a range of testing procedures, including intermittent leachant flow conditions, has been investigated. For cyclic wet/dry leaching tests, extended dry periods tend to enhance the release of Cs and suppress the release of Sr. Under extended wet period leaching conditions, however, both Cs and Sr exhibit suppressed releases. In contrast, radionuclide releases observed under continuously saturated leaching conditions, as represented by conventional leaching tests, are significantly different. The relevance and applicability of these laboratory data obtained under a wide range of leaching conditions to

the performance evaluation of waste forms under anticipated field conditions is discussed.

37552 (CONF-8509121—, pp 302-316) **Characteristics of commercial low-level waste and low-level waste practices - CRCPD LLW surveys.** Osborne, R. (Conference of Radiation Control Program Directors, Inc., Frankfurt, KY). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Conference of Radiation Control Program Directors, Inc., (CRCPD) conducted a survey of waste generators in forty-one (41) states, the District of Columbia, and Puerto Rico. Survey information was collected by use of a questionnaire designed by the CRCPD. This 1982 waste information has been entered into the National Low-Level Waste Management Information System designed by EG & G Idaho, Inc. A general description of the information available from the survey is given including a brief discussion on: completeness of survey, waste management practices, and waste characteristics. In addition, a similar survey is currently being conducted by the CRCPD relative to 1984 data. Survey participants include forty-seven (47) states and the District of Columbia. A brief description of the information that will be available from the 1984 survey is also given.

37553 (CONF-8509121—, pp 317-323) **Identification of radioactive mixed wastes in commercial low-level wastes.** Bowerman, B.S.; Kempf, C.R.; MacKenzie, D.R.; Siskind, B.; Piciulo, P.L. (Brookhaven National Lab., Upton, NY). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

A literature review and survey were conducted on behalf of the US NRC Division of Waste Management to determine whether any commercial low-level radioactive wastes (LLW) could be considered hazardous as defined by EPA under 40 CFR Part 261. The purpose of the study was to identify broad categories of LLW which may require special management as radioactive mixed waste, and to help address uncertainties regarding the regulation of such wastes. Of 239 questionnaires sent out to reactor and non-reactor LLW generators, there were 91 responses representing 29% by volume of all low-level wastes disposed of at commercial disposal sites in 1984. The analysis of the survey results indicated that three waste streams generic to commercial LLW may be potential radioactive mixed wastes. These are as follows: (1) wastes containing organic liquids, disposed of by all types of generators and representing ≈ 2.3% by volume of all wastes reported, (2) wastes containing lead metal, i.e., discarded shielding and lead containers, representing < 0.1% by volume of all wastes reported, and (3) wastes containing chromium, i.e., process wastes from nuclear power plants which use chromates as corrosion inhibitors; these represent 0.6% of the total volume reported in the survey. Certain wastes, specific to particular generators, were identified as potential mixed wastes as well.

37554 (CONF-8509121—, pp 324-333) **Treatment of radioactive mixed wastes in commercial low-level wastes.** Kempf, C.R.; MacKenzie, D.R. (Brookhaven National Lab., Upton, NY). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Management options for three generic categories of radioactive mixed waste in commercial low-level wastes have been identified and evaluated. These wastes were characterized as part of a BNL study in which a large number of generators were surveyed for information on potentially hazardous low-level wastes. The general management targets adopted for mixed wastes are immobilization, destruction, and reclamation. It is possible that these targets may not be practical for some wastes, and for these, goals of stabilization or reduction of hazard are addressed. Solidification, absorption, incineration, acid digestion, segregation, and substitution have been considered for organic liquid wastes. Containment, segregation, and decontamination and re-use have been considered for lead metal wastes which have themselves been contaminated and are not used for purposes of waste disposal shielding, packaging, or containment. For chromium-containing wastes, solidification, incineration, containment, substitution, chemical reduction, and biological removal have been considered. For each of these wastes, the management option evaluation has necessarily included assessment/estimation of the effect of the treatment on both the radiological and potential chemical hazards present.

37555 (CONF-8509121—, pp 334-341) **Threshold guidance update.** Wickham, L.E. (EG & G Idaho, Inc., Idaho Falls). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Department of Energy (DOE) is developing the concept of threshold quantities for use in determining which waste materials must be handled as radioactive waste and which may be disposed of as nonradioactive waste at its sites. Waste above this concentration level would be managed as radioactive or mixed waste (if hazardous chemicals are present); waste below this level would be handled as sanitary waste. Last years' activities (1984) included the development of a threshold guidance dose, the development of threshold concentrations corresponding to the guidance dose, the development of supporting documentation, review by a technical peer review committee, and review by the DOE community. As a result of the comments, areas have been identified for more extensive analysis, including an alternative basis for selection of the guidance dose and the development of quality assurance guidelines. Development of quality assurance guidelines will provide a reasonable basis for determining that a given waste stream qualifies as a threshold waste stream and can then be the basis for a more extensive cost-benefit analysis. The threshold guidance and supporting documentation will be revised, based on the comments received. The revised documents will be provided to DOE by early November. DOE-HQ has indicated that the revised documents will be available for review by DOE field offices and their contractors.

37556 (CONF-8509121—, pp 367-376) **Long-term monitoring for closed sites.** Golchert, N.W.; Sedlet, J.; Veluri, V.R. (Argonne National Lab., IL). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

A procedure is presented for planning and implementing a long-term environmental monitoring program for closed low-level radioactive waste disposal sites. The initial task in this procedure is to collect the available information on the legal/regulatory requirements, site and area characteristics, source term, pathway analysis, and prior monitoring results. This information is coupled with parameters such as half-life and retardation factors to develop a monitoring program. As examples, programs are presented for a site that has had little or no waste migration, and for sites where waste has been moved by surface water, by ground water, and by air. Sampling techniques and practices are discussed relative to how a current program would be structured and projections are made on techniques and practices expected to be available in the future.

37557 (CONF-8509121—, pp 377-388) **Low-level waste management at the West Valley Demonstration Project.** Maestas, E.; Cwynar, J.C.; Goodman, J. (DOE West Valley Project Office). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The West Valley Demonstration Project requires a fully integrated waste management system. The spectrum of Project activities includes spent fuel shipments, high-level waste solidification, facility decontamination and dismantlement, and storage and disposal of wastes. Criteria have been developed to establish waste form requirements for disposal of Project low-level waste consistent with the appropriate requirements of 10 CFR 61 and DOE Order 5820.2. Low-level waste flow diagrams, waste form recipe development, and treatment systems are described.

37558 (CONF-8509121—, pp 389-399) **Tritium migration at the low-level radioactive waste disposal site at Maxey Flats near Morehead, Kentucky.** Lyverse, M.A. (Geological Survey, Louisville, KY). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

High values of specific conductance and tritium concentrations have been detected in ground water samples from wells along the perimeter of a low-level radioactive waste disposal site at Maxey Flats, near Morehead, KY. Test wells have shown that ground water flow in the shallow sedimentary rocks at the site is controlled primarily by naturally occurring joints and fractures. Ground water containing tritium concentrations (1.5 - 3.5 microcuries per milliliter) and specific conductance values (2600 - 4500 microsiemens per centimeter) is associated with a horizontal sandstone bed (about 15 feet below land surface) which probably has a higher density of open joints and fractures than the predominant overlying and underlying shales. These joints and fractures probably act as conduits for ground water flow from the topographically higher burial trenches to the downslope observation wells. Specific conductance values and tritium concentrations in ground water from wells where the sandstone bed is thin or nonexistent are much lower. Although tritium concentrations and specific conductance values from some offsite wells downslope of the burial grounds are high and water appears to be moving primarily in the fractured sandstone bed, water-quality measurements from small seeps and ephemeral streams in the outcrop area near the wells indicate that contaminated water is not reaching the land surface on the hill slope in this particular location. Plotted elevations of the fractured sandstone bed (obtained from levels) has resulted in the detection of a small anticline which may inhibit ground water flow to this outcrop area. Also, existing fractures are more likely to become plugged with colluvium and weathered shale where the sandstone is near land surface, thus further impeding flow.

37559 (CONF-8509121—, pp 400-415) **Field studies and modeling of chemical processes in the unsaturated zone.** Polzer, W.L.; Fuentes, H.R. (Los Alamos National Lab., NM). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Technical assistance is being provided to Nuclear Materials Safety and Safeguards of the Nuclear Regulatory Commission to evaluate the validity of several guidelines listed in 10 CFR Part 61 for the future burial of low-level radioactive waste. Those guidelines include the requirement that the burial site shall be capable of being modeled. Both laboratory- and field-scale studies are being conducted under unsaturated moisture conditions and under steady-state and unsteady-state flow conditions. This paper reviews the kinds of experiments in low-level radioactive waste disposal in development at the Los Alamos National Laboratory. Major emphasis is on some of the initial analyses of data for laboratory sorption experiments and for field transport tests. Brief reference is made to leaching and transport studies. Laboratory batch equilibrium sorption studies suggest that adsorption of nonconservative tracers can be described in terms of two empirical constants; one gives an indication of the average K/sub d/ for all adsorption sites and the other gives an indication of the spread of individual K/sub d/'s about the average K/sub d/. This information can be translated into a chemical dispersion under dynamic flow and equilibrium sorption conditions that is in addition to the traditionally accepted physical dispersion. Laboratory nonequilibrium sorption studies suggest that nonequilibrium models may be needed to model the transport of the nonconservative tracers cobalt and cesium; equilibrium models should be suitable to model strontium transport. Analyses from field-scale studies indicate that conservative tracers can reasonably be modeled with a one-dimensional advective-dispersive equation for steady flow. 12 figures, 1 table.

37560 (CONF-8509121—, pp 416-423) **Environmental monitoring at low-level waste shallow-land burial sites.** Blanchfield, L.A.; Moor, K.S. (EG & G Idaho, Inc., Idaho Falls). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The objective of this task is to document routine environmental surveillance activities conducted at major low-level waste (LLW) shallow-land burial (SLB) sites. Monitoring activities at six Department of Energy (DOE) sites and three commercial sites were observed. Techniques presently in use at these disposal sites for monitoring environmental levels of radioactivity in air, surface water, surface soil, and for monitoring penetrating radiation are being documented. A final report will be available in fiscal year 1986. This paper summarizes the types of monitoring at the major DOE LLW disposal sites. Groundwater is monitored at most disposal sites as part of DOE reservation-wide monitoring networks. Air monitoring is emphasized at arid sites, while water monitoring is emphasized at humid sites. All sites utilize thermoluminescent dosimetry (TLDs) to monitor disposal site perimeters or as part of a DOE reservation-wide network. Frequency and methods for surface radiation surveys vary among sites.

37561 (CONF-8509121—, pp 427-432) **Greater confinement disposal program at the Savannah River Plant.** Towler, O.A.; Cook, J.R. (E.I. du Pont de Nemours and Co., Aiken, SC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC09-76SR00001.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

A demonstration Greater Confinement Disposal facility, consisting of twenty GCD boreholes, began accepting solid low-level radioactive waste at the Savannah River plant in 1984. Three of the boreholes have been filled with the higher activity fraction of SRP solid waste. They have been stabilized with grout to prevent subsidence and reduce water infiltration. Closure will take place when all twenty boreholes have been filled. A Greater Confinement Disposal trench project is underway, with construction scheduled to begin in November 1985. Trench volume will be 100,000 cubic feet.

37562 (CONF-8509121—, pp 433-450) **Planning for greater-confinement disposal.** Gilbert, T.L.; Luner, C.; Meshkov, N.K.; Trevorrow, L.E.; Yu, C. (Argonne National Lab., IL). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

A report that provides guidance for planning for greater confinement disposal (GCD) of low-level radioactive waste is being prepared. The report addresses procedures for selecting a GCD technology and provides information for implementing these procedures. The focus is on GCD; planning aspects common to GCD and shallow-land burial are covered by reference. Planning procedure topics covered include regulatory requirements, waste characterization, benefit-cost-risk assessment and pathway analysis methodologies, determination of need, waste-acceptance criteria, performance objectives, and comparative assessment of attributes that support these objectives. The major technologies covered include augered shafts, deep trenches, engineered structures, hydrofracture, improved waste forms, and high-integrity containers. Descriptive information is provided, and attributes that are relevant for risk assessment and operational requirements are given.

37563 (CONF-8509121—, pp 451-460) **Contaminated scrap metal management at the ORGDP - a problem solved.** Williams, L.C. (Oak Ridge National Lab., TN). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC05-84OR21400.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Cleanup operations are currently in progress at the Oak Ridge Gaseous Diffusion Plant (ORGDP) contaminated scrap metal storage yard. The storage yard, in existence since the early 1970s, contains an estimated 30,000 tons of contaminated mixed-type metals spread over an area of roughly 30 acres. Work is currently underway to remove the metal from the storage yard, sort into the various types, and size reduce specific types for overall volume reduction and possible further processing in the future. This paper explains the methods and procedures used to accomplish this

task. The scrap metal is contaminated with low-enriched uranium, ^{99}Tc, and trace amounts of transuranics.

37564 (CONF-8509121—, pp 461-476) **Alternative methods for LLW disposal: summary of methods and assessment of technical criteria.** Bennett, R.D. (Army Engineer Waterways Experiment Station, Vicksburg, MS). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Alternative disposal methods considered were aboveground vaults, below ground vaults, earth-mounded concrete bunkers, shafts, and mined cavities. Technical criteria of 10 CFR Part 61, Subpart D, paragraphs 61.50-61.53, released to site suitability, design, operations, closure, and monitoring were assessed for applicability to each method. With few exceptions, these criteria are appropriate to evaluate 4 of the 5 methods. A few criteria may require modification or guidance and additional technical issues should be addressed in certain cases. The existing criteria are insufficient to completely evaluate mined cavity disposal. This alternative should perform satisfactorily, given proper site conditions, but is quite different from near surface disposal. Some criteria are inapplicable, some require modification, and additional issues must be addressed to evaluate this method. Although the technical criteria are adequate to evaluate aboveground vault disposal, satisfaction of the performance objectives and minimum technical requirements will be difficult with this alternative. The 4 disposal methods to which the Part 61 criteria apply directly are discussed.

37565 (CONF-8509121—, pp 477-491) **Analysis of low-level radioactive waste disposal technologies.** Shaw, R.A.; Rogers, V.C.; Baird, R.D.; Sutherland, A.A. (Electric Power Research Institute, Palo Alto, CA). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

A methodology for classifying low-level radioactive waste (LLW) disposal technologies is presented. The methodology is based on the functions which must be performed by disposal facilities and the functional features incorporated to accomplish the functions. Disposal technologies are uniquely classified by reference to four functional features: the location of the facility relative to natural grade, the existence and extent of cover material, structural capability provided by the facility, and the presence and characteristics of fill material. The applicability and adequacy of 10CFR61 requirements to LLW disposal technologies other than shallow land burial is presented and discussed.

37566 (CONF-8509121—, pp 492-497) **Worldwide low-level waste disposal practices.** Towler, O.A. (E.I. du Pont de Nemours and Co., Aiken, SC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC09-76SR00001.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Low-level waste disposal practices will be described for the following countries: Canada, Belgium, France, West Germany, Sweden, Denmark, Italy, Japan, Switzerland, and the United Kingdom. These practices will be compared with expectations for disposal designs for low-level waste regional compacts in the US.

37567 (CONF-8509121—, pp 501-503) **Disposal facility, host state and site selection process in the Southeast Compact.** Godwin, A.V. (Alabama Dept. of Public Health). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Southeast Interstate Low-Level Radioactive Waste Management Compact envisions a multistep process to identify the net regional disposal site. The first part of that process is the selection of the host state. The final site selection is made by the designated host state. The Southeast Low Level Radioactive Waste Management Compact consists of the states of Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. All of the states have approved the compact and are awaiting consent by Congress. Under the terms of the compact a host state for a disposal facility must be designated by July 21 of 1986. Further, each party state is to require a minimization of waste generation within the state.

37568 (CONF-8509121—, pp 504-517) **Potential problem areas: extended storage of low-level radioactive waste.** Siskind, B. (Brookhaven National Lab., Upton, NY). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

If a state or regional compact does not have adequate disposal capacity for low-level radioactive waste (LLRW), then extended storage of certain LLRW may be necessary. The Nuclear Regulatory Commission (NRC) has contracted with Brookhaven National Laboratory to address the technical issues of extended storage. The dual objectives of this study are (1) to provide practical technical assessments for NRC to consider in evaluating specific proposals for extended storage and (2) to help ensure adequate consideration by NRC, Agreement States, and licensees of potential problems that may arise from existing or proposed extended storage practices. Storage alternatives are considered in order to characterize the likely storage environments for these wastes. In particular, the range of storage alternatives considered and being implemented by the nuclear power plant utilities is described. The properties of the waste forms and waste containers are discussed. An overview is given of the performance of the waste package and its contents during storage (e.g., radiolytic gas generation, corrosion) and of the effects of extended storage on the performance of the waste package after storage (e.g., radiation-induced embrittlement of polyethylene, the weakening of steel containers by corrosion). Additional information and actions required to address these concerns, including possible mitigative measures, are discussed.

37569 (CONF-8509121—, pp 518-530) **Technology, socio-political acceptance, and the low-level radioactive waste disposal facility.** Andrews, L.J.; Domenech, J.S. (Chem-Nuclear Systems, Inc.). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The technology which is required to develop and operate low-level radioactive waste disposal sites in the 1990's is available today. The push for best available technology is a response to the political difficulties in securing public acceptance of the site selection process. Advances in waste management technologies include development of High Integrity Containers (HIC), solidification media, liquid volume reduction techniques using GEODE/sub sm/ and DeVoe-Holbein technology of selective removal of target radioisotopes, and CASTOR V storage casks. Advances in technology alone, however, do not make the site selection process easier and without socio-political acceptance there may be no process at all. Chem-Nuclear has been successful in achieving community acceptance at the Barnwell facility and elsewhere. For example, last June in Fall River County, South Dakota, citizens voted almost 2:1 to support the development of a low-level radioactive waste disposal facility. In Edgemont, the city nearest the proposed site, 85% of the voters were in favor of the proposed facility.

37570 (CONF-8509121—, pp 531-534) **Public participation - an approach in the Central Midwest region.** Lash, T.R. (Illinois Dept. of Nuclear Safety). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The State of Illinois and the Commission for the Central Midwest Compact are committed to providing for extensive public involvement in developing a LLW management program for the state and the region. The Illinois Department of Nuclear Safety, the state agency responsible for siting the new disposal facility in Illinois, has developed the staff resources needed to plan and implement public involvement activities such as informational mailings, public meetings and workshops, and formal public hearings, in an effort to meet this commitment. To establish a fair and open process that can lead to the siting of a LLW disposal facility in Illinois, the Department believes a public involvement program must be given institutional support and attention equal to that given the technical side of siting. In addition, the program must include

mechanisms for resolving conflict among the interested parties at every stage of the siting process.

37571 (CONF-8509121—, pp 535-542) **Decision process for siting low-level radioactive waste disposal facilities: a role for the public.** Wiltshire, S.D. Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Low-Level Radioactive Waste Policy Act of 1980 placed responsibility for providing low-level waste disposal capacity on state governments intending that new disposal facilities be developed. However, no new sites have been chosen. The impasse is due partly to lack of political and citizen support for siting facilities. This paper reflects the analysis of the experiences of agency officials in six states by a Review Group of the Program Review Committee of the National Low-Level Waste Management Program. The paper discusses the role of public involvement in decision-making. A rationale and set of goals for public involvement processes are outlined. Finally, possible future actions of the National Low-Level Management Program to assist state agency officials responsible for the siting of low-level waste facilities are described.

37572 (CONF-8509121—, pp 543-550) **Siting simulation for low-level waste disposal facilities.** Roop, R.D.; Rope, R.C. (Oak Ridge National Lab., TN). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC05-84OR21400.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Mock Site Licensing Demonstration Project has developed the Low-Level Radioactive Waste Siting Simulation, a role-playing exercise designed to facilitate the process of siting and licensing disposal facilities for low-level waste (LLW). This paper describes the development, content, and usefulness of the siting simulation. The simulation can be conducted at a workshop or conference, involves 14 or more participants, and requires about eight hours to complete. The simulation consists of two sessions; in the first, participants negotiate the selection of siting criteria, and in the second, a preferred disposal site is chosen from three candidate sites. The project has sponsored two workshops (in Boston, Massachusetts and Richmond, Virginia) in which the simulation has been conducted for persons concerned with LLW management issues. It is concluded that the simulation can be valuable as (1) a tool for disseminating information about LLW management, (2) a vehicle that can foster communication, and (3) a step toward consensus building and conflict resolution. The DOE National Low-Level Waste Management Program is now making the siting simulation available for use by states, regional compacts, and other organizations involved in development of LLW disposal facilities.

37573 (CONF-8509121—, pp 551-556) **Virginia public participation program.** Wrenn, B.M. Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Too often, the technical and regulatory communities have viewed public involvement in decision making processes as a series of delays and a loss of control over the outcome. However, in low-level waste management, attempting to proceed without public involvement is a gamble with odds against success. Before a public participation program is developed, determine (1) level of commitment to public participation; (2) identification of interested parties, their roles and power to influence public opinion; and (3) legal requirements for administrative procedures. Time required for soliciting, considering and incorporating public input should be structured into the process, with the realization that the public can enhance the results. In 1982, Virginia initiated a public participation program with funding assistance from the Department of Energy. The program is administered by a commission within the legislative branch of government. As currently planned, the program will end in mid-1986 when the Southeast Compact Commission has identified the next state to host a regional facility. Techniques used include briefings, news releases, local meetings, questionnaires, newsletters, establishment of a citizen advisory committee and public hearings. There appears to be no magic formula for public involvement in low-level waste management decisions.

37574 (CONF-8509121—, pp 559-563) **Midwest regional management plan.** Paton, R.F. (Midwest Interstate Low-Level Radioactive Waste Commission). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

In response to the Low-Level Radioactive Waste Policy Act of 1980, the States of Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin formed the Midwest Interstate Low-Level Radioactive Waste Compact. One of the top priorities of the Compact Commission is the development of a comprehensive regional waste management plan. The plan consists of five major elements: (1) waste inventory; (2) waste stream projections; (3) analysis of waste management and disposal options; (4) development of a regional waste management system; and (5) selection of a host state(s) for future low-level waste facilities. When completed, the Midwest Management Plan will serve as the framework for future low-level radioactive waste management and disposal decisions.

37575 (CONF-8509121—, pp 564-569) **DOE's low-level waste disposal site transfer program: a status update.** Rutz, A.C.; Jennrich, E.A. (EG & G Idaho, Inc., Idaho Falls). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Nuclear Waste Policy Act of 1982 (Section 151) authorizes the Secretary of the Department of Energy to accept title and custody of low-level and special radioactive waste sites under stipulated conditions. The DOE has developed programmatic guidance for the prospective transfer of candidate sites and has requested NRC review and comment pending negotiations on a memorandum of understanding. To assist in the development of the programmatic guidance and to determine the type of information readily available to support a proposed transfer, the DOE has reviewed the available information pertaining to the Sheffield, Illinois Low-Level Waste Disposal Site. The background and recent development in this new program are described.

37576 (CONF-8509121—, pp 570-578) **Temporary storage of low-level radioactive waste in New York.** Dunkleberger, J.D.; Schwarz, W.F. (New York State Energy Office). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

When it became clear that a new permanent low-level radioactive waste disposal facility could not be sited, licensed, and constructed in New York by January 1, 1986, planning for a temporary storage facility was begun as a hedge against loss of continued access. Several basic design concepts for aboveground, monitored, retrievable storage were evaluated, and volume reduction by incineration was considered. Cost projections for storage concepts with and without incineration were developed, based largely upon nuclear plant storage facility costs in New York. Technical requirements for a storage facility were developed in preparation for soliciting bids for design, licensing, and construction. The facility was to be located at West Valley, and would be operated by the State. Legislation which would have authorized licensing, construction, and operation of the facility as part of New York's low-level waste management plan was submitted but not enacted. It will be reconsidered in October 1985.

37577 (CONF-8509121—, pp 579-584) **Regional treatment/disposal information system.** Loughead, J.S.C. (EG & G Idaho, Inc., Idaho Falls). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Completion of this project will provide a system of linked, independent evaluation models which can be utilized to assess various treatment and disposal technology configurations for regional low-level waste management. This system will be comprised of several distinct models, all developed in a compatible format so that they may be utilized together for analyzing a complete regional system. The integrated system of models is envisioned to be a deci-

sion-making tool for technical personnel within a specific state or region, allowing the prompt, consistent comparison of various technology configurations for managing low-level radioactive waste. Each independent model may be invoked separately, or as a subroutine of the integrated system.

37578 (CONF-8509121—, pp 585-592) **Monitoring low-level waste allocations for compliance with limited availability provisions during transition and licensing periods.** Hill, G.R. (Southern States Energy Board, Atlanta, GA). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The US Congress is considering legislation that establishes interstate compacts for low-level radioactive waste disposal. Congressional attention currently focuses on requirements states must meet to retain access to operating sites after the compacts' exclusionary authority becomes effective in 1986. The requirements are being debated as amendments regarding Limited Availability of Certain Regional Disposal Facilities during Transition and Licensing Periods. Limited availability provisions will mandate use of effective data systems to monitor waste allocations specified for commercial nuclear power reactors. A prototype system will be reviewed for the southeastern region of the US to demonstrate how the monitoring tasks might be accomplished in accordance with legislative intent.

37579 (CONF-8509121—, pp 593-599) **Common data system for low-level waste management.** Fuchs, R.L. (National Low-Level Waste Management Program). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The efficient use of data throughout the Low-Level Waste Management area is dependent on the proper and expedient use of information collected from many different sources. This need has lead to the development of an information system sponsored by the Department of Energy (DOE) and housed at the Idaho National Engineering Laboratory (INEL). Objectives of this information system are to optimize the use of common data and to ensure the accuracy of that data by providing on-line accessing methods to data originators. This presentation will cover systems which are presently operational at the INEL and provide information on how to gain access to those systems.

37580 (CONF-8509121—, pp 600-604) **Disposal Site Information Management System.** Larson, R.A.; Jouse, C.A.; Esparza, V. (EG & G Idaho, Inc., Idaho Falls). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

An information management system for low-level waste shipped for disposal has been developed for the Nuclear Regulatory Commission (NRC). The Disposal Site Information Management System (DSIMS) was developed to provide a user friendly computerized system, accessible through NRC on a nationwide network, for persons needing information to facilitate management decisions. This system has been developed on NOMAD VP/CSS, and the data obtained from the operators of commercial disposal sites are transferred to DSIMS semiannually. Capabilities are provided in DSIMS to allow the user to select and sort data for use in analysis and reporting low-level waste. The system also provides means for describing sources and quantities of low-level waste exceeding the limits of NRC 10 CFR Part 61 Class C. Information contained in DSIMS is intended to aid in future waste projections and economic analysis for new disposal sites.

37581 (CONF-8509121—, pp 605-613) **Development of a plan for a national LLW information management system based on data acquired from a uniform manifest.** Gingerich, R.; Shimer, R.P. (Inter/Face Associates, Middletown, CT). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Western Governors' Association (WGA), with funding from the Department of Energy's (DOE) National Low-Level Radioactive Waste Management Program, has completed an 18-month national project to develop a plan for a national low-level waste (LLW) information management system based on data from a uniform manifest for shipments of LLW. Under the plan, waste generators would fill out a manifest for a shipment just as they do currently, but they would use a nationally standard form. Shortly after a shipment arrives at a disposal facility or a processor, data from the manifest would be entered into the Program's Low-Level Waste Information Management System (LLWIMS). The data would be available via computer to state, compact and federal officials. This paper provides an overview of the plan for implementing and operating a national information management system linked to manifest data. It reports on the progress that has been made toward implementing the system and outlines the work that remains to be done. Finally, the paper examines the crucial role the system will play in the development of an acceptable system for managing the nation's LLW, particularly in the post-1986 transition period.

37582 (CONF-8509121—, pp 632-654) **Interim management and site stabilization at a closed commercial shallow land burial facility.** Hornibrook, C.A. (New York State Energy Research and Development Authority, Albany). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The New York State Energy Research and Development Authority is the custodial agency responsible for the closed commercial low-level radioactive waste (LLRW) disposal area in West Valley, New York. In this regard, the Energy Authority, in cooperation with the US Department of Energy, has initiated a project with the following primary objectives: (1) formulate a recommended strategy for permanent stabilization of the LLRW disposal area; design a project to demonstrate the potential effectiveness of the trench stabilization portion of the plan and develop an improved interim site management plan for use until the stabilization plan is implemented; (2) identify West Valley LLRW disposal experiences that may apply to the development of new disposal facilities at other sites with similar characteristics; and (3) evaluate the LLRW disposal area's site characteristics in light of pertinent regulatory requirements. Based upon a detailed literature review, the West Valley LLRW disposal area site characteristics were summarized and site problems to be addressed by the site stabilization plan were identified. A systematic evaluation of the Universe of Design Elements capable of correcting these problems led to the development of six site stabilization candidates. This presentation will briefly describe the characteristics and operational history of the LLRW disposal area and the status of the project to date. In addition, the process that identified and ranked six candidate plans, and the implications and associated costs of instituting specific candidate plans, will be discussed.

37583 (CONF-8509121—, pp 655-675) **Maxey Flats Nuclear Waste Disposal Site in situ waste grouting demonstration - results to date.** Haight, C.P.; Mills, D.; Razor, J. (Kentucky Natural Resources & Environmental Protection Cabinet, Frankfort). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract FG07-81ID12223.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

At the 1984 DOE LLWMP meeting, the Kentucky Natural Resources and Environmental Protection Cabinet presented its experiences during the initial phases of a field demonstration of an in situ chemical grouting technology at the Maxey Flats Nuclear Waste Disposal Site in Fleming County, Kentucky. Due to the date of the LLWMP meeting and the completion of the injection procedure, only limited information was available concerning the results of the demonstration. This paper will report on one year of data collection since the injection of the sodium silicate grout into the trench test cell. Results and conclusions will be presented where sufficient data exists. Surface elevation data suggests no subsidence has occurred within the grouted test cell nor the remaining ungrouted sections of the trench. Hydraulic conductivity measurements at four locations within the grouted test cell have been increasing over the past year. This data may suggest the grout is degrading with time.

37584 (CONF-8509121—, pp 676-698) **Burial trench dynamic compaction demonstration at a humid site.** Spalding, B.P. (Oak Ridge National Lab., TN). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

This task has the objective of determining the degree of consolidation which can be achieved by dynamic compaction of a closed burial trench within a cohesive soil formation. A seven-year-old burial trench in Solid Waste Storage Area (SWSA) 6 of Oak Ridge National Laboratory (ORNL) was selected for this demonstration. This 251 m^3 trench contained about 80 Ci of mixed radionuclides, mostly ^{90}Sr, in 25 m^3 of waste consisting of contaminated equipment, dry solids, and demolition debris. Prior to compaction, a total trench void space of 79 m^3 was measured by pumping the trench full of water with corrections for seepage. Additional precompaction characterization included trench cap bulk density (1.68 kg/L), trench cap permeability (3×10^{-7} m/s), and subsurface waste/backfill hydraulic conductivity (> 0.01 m/s). Compaction was achieved by repeatedly dropping a 4-ton steel-reinforced concrete cylinder from heights of 4 to 8 m using the whipline of a 70-ton crane. The average trench ground surface was depressed 0.79 m, with some sections over 2 m, yielding a surveyed volumetric depression which totaled to 64% of the measured trench void space. Trench cap (0-60 cm) bulk density and permeability were not affected by compaction indicating that the consolidation was largely subsurface. Neither surface nor airborne radioactive contamination were observed during repeated monitoring during the demonstration. Dynamic compaction was shown to be an excellent and inexpensive (i.e. about $20/$m^3$) method to collapse trench void space, thereby hastening subsidence and stabilizing the land surface. 15 references, 10 figures, 3 tables.

37585 (CONF-8509121—, pp 699-704) **Liquid disposal site void fill and isolation: systems description.** Phillips, S.J.; Winterhalder, J.A.; Bernard, D.L.; Gilbert, T.W. (Rockwell Hanford Operations, Richland, WA). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Several different types of structures have been used to dispose of liquid low-level radioactive wastes. The design of these structures typically included significant void volume, both within the structures and within the underlying backfill materials. This void volume permits infiltration of liquids from the structure to the substrate, while retaining specific radionuclides near the base of the structure. A need to fill the void volume in and around these structures has become apparent as these structures are often geomechanically unstable. This instability, if left untreated, may result in direct and indirect pathways for exposure to contaminants. This paper describes design, configuration, and operation of a prototypic system being used to develop corrective measures for closure of liquid disposal cribs. The system primarily consists of a mobile grout plant coupled with a vibratory hammer extractor. Options for system operations may include: (1) gravity or pressure injection of particulate grout directly into waste disposal structures; (2) pressure injection of grout directly into gravel fill both surrounding and below disposal structures; or (3) dynamic consolidation of the structure and surrounding materials simultaneously with pressure grout injection. The system is currently being tested at the US Department of Energy's Hanford Site located at Richland, Washington.

37586 (CONF-8509121—, pp 705-724) **Status of corrective measures technology for shallow land burial at arid sites.** Abeele, W.V.; Nyhan, J.W.; Drennon, B.J.; Lopez, E.A.; Herrera, W.J.; Langhorst, G.J. (Los Alamos National Lab., NM). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The field research program involving corrective measure technologies for arid shallow land burial sites is described. Soil erosion and infiltration of water into a simulated trench cap with various surface treatments was measured and compared with similar data from agricultural systems across the US. Report of field testing of biointrusion barriers continues at a closed-out waste disposal site at Los Alamos. Final results of an experiment designed to determine the effects of subsidence on the performance of a cobble-gravel biobarrier system are reported, as well as the results of hydrologic modeling activities involving biobarrier systems. 11 references, 10 figures.

37587 (CONF-8509121—, pp 725-736) **Variability in the partial pressures of gases in the unsaturated zone adjacent to a low-level radioactive-waste disposal site near Sheffield, Illinois.** Striegl, R.G.; Ruhl, P.M. (Univ. of Wisconsin, Madison). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

As part of a continuing study to investigate the transport of gases in the unsaturated zone, as many as eight gas samples have been collected from each of 15 gas piezometers screened in undisturbed Pleistocene deposits adjacent to a low-level radioactive-waste disposal site near Sheffield, Illinois. The samples were analyzed for partial pressures of nitrogen, oxygen plus argon, carbon dioxide, methane, ethane, propane, and butane. Several samples were also analyzed for tritiated water vapor, ^{14}carbon dioxide, and ^{222}radon. Methane and ^{14}carbon dioxide, originating at the buried wastes, showed concentration gradients that diminished eastward from the site, and vertically to the atmosphere. Concentrations of ^{222}radon were highly elevated relative to atmospheric air, but gradients originating from wastes were not determined. Total carbon dioxide, and oxygen plus argon exhibited seasonal concentration patterns characterized by near-surface pulses of carbon dioxide produced by root respiration in the summer, and little or no measurable influence from the buried wastes. Trace quantities of propane and isobutane were detected in several samples collected from the boreholes nearest the buried wastes. Ethane, n-butane, and tritiated water vapor were not detected at above-background concentrations.

37588 (CONF-8509121—, pp 737-753) **Collapse and erosion at the low-level radioactive-waste burial site near Sheffield, Illinois.** Gray, J.R.; McGovern, L.L. (Geological Survey, Urbana, IL). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Collapse and erosion are the dominant landform-modification processes at the Sheffield, Illinois, low-level radioactive-waste burial site. Records on collapse have been collected by the site contractor since 1978 and include data of inspection, location, and cavity dimensions. Fluvial sediment yield was measured by the US Geological Survey beginning in July 1982 from three gaged areas which drained two-thirds of the 20-acre site, and from a gaged 3.5-acre area in undisturbed terrain 0.3 mile south of the site. A total of 302 collapse cavities were recorded from October 1978 through September 1985. Based on the weight of earth material equivalent to cavity volume, an annual average of 6 tons of sediment per acre of site area has moved downward due to collapse. Sixty-two percent of the collapses occurred in swales between waste-disposal trenches or near trench boundaries, while the remainder occurred in earth material covers over trench interiors. Two-thirds of the collapses occurred during the months of February, March, and April. On-site fluvial sediment yield averaged 2 tons per acre per year from July 1982 through July 1984. Although this yield was approximately 200 times that from the undisturbed area, it is about one-half the annual sediment yield expected from a 20-acre row-crop agricultural basin on an 8% slope near Sheffield.

37589 (CONF-8509121—, pp 757-774) **Sensitivity analyses of EPA's codes for assessing potential health risks from disposal of low-level wastes.** Bandrowski, M.S.; Hung, C.Y.; Meyer, G.L. (Environmental Protection Agency, Washington, DC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Environmental Protection Agency is developing generally applicable environmental standards for land disposal of low-level radioactive wastes. Comparing potential health risks to general populations and critical population groups from land disposal of

LLW under a wide variety of disposal methods and hydrogeologic and climatic conditions is an important part of EPA's standards development process. EPA has developed the PRESTO family of risk assessment codes to compare these health risks. This paper presents a preliminary report on the sensitivity analysis phase of EPA's overall program to verify and validate the PRESTO models and codes. In the sensitivity analyses, input parameters related to waste form and composition, hydrogeologic and climatic conditions at the disposal site, and engineering barriers used were systematically varied to ensure that the models behave logically and to identify parameters having pronounced impacts on model output. Parameters tested, why tested, and summaries of qualitative results of tests of the PRESTO-EPA-POP and PRESTO-EPA-CPG codes are described.

37590 (CONF-8509121—, pp 775-786) **Development and applications of two finite element groundwater flow and contaminant transport models: FEWA and FEMA.** Yeh, G.T.; Wong, K.V.; Craig, P.M.; Davis, E.C. (Oak Ridge National Lab., TN). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC05-84OR21400.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

This paper presents the construction, verification, and application of two groundwater flow and contaminant transport models: A Finite Element Model of Water Flow through Aquifers (FEWA) and A Finite Element Model of Material Transport through Aquifers (FEMA). The construction is based on the finite element approximation of partial differential equations of groundwater flow (FEWA) and of solute movement (FEMA). The particular features of FEWA and FEMA are their versatility and flexibility for dealing with nearly all vertically integrated two-dimensional problems. The models were verified against both analytical solutions and widely used US Geological Survey finite difference approximations. They were then applied for calibration and validation, using data obtained in experiments at the Engineering Test Facility at Oak Ridge National Laboratory. Results indicated that the models are valid for this specific site. To demonstrate the versatility and flexibility of the models, they were applied to two hypothetical, but realistic, complex problems and three field sites across the US. In these applications the models yielded good agreement with the field data for all three sites. Finally, the predictive capabilities of the models were demonstrated using data obtained at the Hialeah Preston site in Florida. This case illustrates the capability of FEWA and FEMA as predictive tools and their usefulness in the management of groundwater flow and contaminant transport.

37591 (CONF-8509121—, pp 787-797) **Overview of the geochemical code MINTEQ: applications to performance assessment for low-level wastes.** Graham, M.J.; Peterson, S.R. (Pacific Northwest Lab., Richland, WA). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC06-76RL01830.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The MINTEQ geochemical computer code, developed at Pacific Northwest Laboratory (PNL), integrates many of the capabilities of its two immediate predecessors, WATEQ3 and MINEQL. MINTEQ can be used to perform the calculations necessary to simulate (model) the contact of low-level waste solutions with heterogeneous sediments or the interaction of ground water with solidified low-level wastes. The code is capable of performing calculations of ion speciation/solubility, adsorption, oxidation-reduction, gas phase equilibria, and precipitation/dissolution of solid phases. Under the Special Waste Form Lysimeters-Arid program, the composition of effluents (leachates) from column and batch experiments, using laboratory-scale waste forms, will be used to develop a geochemical model of the interaction of ground water with commercial solidified low-level wastes. The wastes being evaluated include power reactor waste streams that have been solidified in cement, vinyl ester-styrene, and bitumen. The thermodynamic database for the code is being upgraded before the geochemical modeling is performed. Thermodynamic data for cobalt, antimony, cerium, and cesium solid phases and aqueous species are being added to the database. The need to add these data was identified from the characterization of the waste streams. The geochemical model developed from the laboratory data will then be applied to predict the release from a field-lysimeter facility that contains full-scale waste samples. The contaminant concentrations migrating from the wastes predicted using MINTEQ will be compared to the long-term lysimeter data. This comparison will constitute a partial field validation of the geochemical model.

37592 (CONF-8509121—, pp 798-813) **Automating sensitivity analysis of computer models using computer calculus.** Oblow, E.M.; Pin, F.G. (Oak Ridge National Lab., TN). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

An automated procedure for performing sensitivity analysis has been developed. The procedure uses a new FORTRAN compiler with computer calculus capabilities to generate the derivatives needed to set up sensitivity equations. The new compiler is called GRESS - Gradient Enhanced Software System. Application of the automated procedure with direct and adjoint sensitivity theory for the analysis of non-linear, iterative systems of equations is discussed. Calculational efficiency consideration and techniques for adjoint sensitivity analysis are emphasized. The new approach is found to preserve the traditional advantages of adjoint theory while removing the tedious human effort previously needed to apply this theoretical methodology. Conclusions are drawn about the applicability of the automated procedure in numerical analysis and large-scale modelling sensitivity studies.

37593 (CONF-8509121—, pp 814-827) **Savannah River Laboratory DOSTOMAN code - a compartmental pathways computer model of contaminant transport.** King, C.M.; Wilhite, E.L.; Root, R.W. Jr.; Fauth, D.J.; Routt, K.R.; Emslie, R.H.; Beckmeyer, R.R.; Fjeld, R.A.; Hutto, G.A.; Vandeven, J.A. (Savannah River Lab., Aiken, SC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC09-76SR00001.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Savannah River Laboratory DOSTOMAN code has been used since 1978 for environmental pathway analysis of potential migration of radionuclides and hazardous chemicals. The DOSTOMAN work will be reviewed including a summary of historical use of compartmental models, the mathematical basis for the DOSTOMAN code, examples of exact analytical solutions for simple matrices, methods for numerical solution of complex matrices, and mathematical validation/calibration of the SRL code. The review includes the methodology for application to nuclear and hazardous chemical waste disposal, examples of use of the model in contaminant transport and pathway analysis, a user's guide for computer implementation, peer review of the code, and use of DOSTOMAN at other Department of Energy sites.

37594 (CONF-8509121—, pp 828-846) **Radionuclide migration in groundwater at a low-level waste disposal site: a comparison of predictive performance modeling versus field observations.** Robertson, D.E.; Myers, D.A.; Abel, K.H.; Bergeron, M.P.; Champ, D.R.; Killey, R.W.D.; Moltyaner, G.L.; Young, J.L. (Pacific Northwest Lab., Richland, WA). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

This paper describes a project which is structured to test the concept of modeling a shallow land low-level waste burial site. The project involves a comparison of the actual observed radionuclide migration in groundwaters at a 30-year old well-monitored field site with the results of predictive transport modeling. The comparison is being conducted as a cooperative program with the Atomic Energy of Canada Ltd. (AECL) at the low-level waste management area at the Chalk River Nuclear Laboratories, Ontario, Canada. A joint PNL-AECL field investigation was conducted in 1983 and 1984 to compliment the existing extensive data base on actual radionuclide migration. Predictive transport modeling is currently being conducted for this site; first, as if it were a new location being considered for a low-level waste shallow-land burial site and only minimal information about the site were available, and

second, utilizing the extensive data base available for the site. The modeling results will then be compared with the level of effort needed to reasonably predict the spacial and temporal movement of radionuclides in the groundwater environment.

37595 (CONF-8509121—, pp 847-853) **Intruder dose pathway analysis code for onsite land disposal.** Kennedy, W.E. Jr.; Peloquin, R.A.; Napier, B.A. (Pacific Northwest Lab., Richland, WA). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152. Contract AC06-76RL01830.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The objective of the current project is to modify an existing pathway-to-man computer program, the MAXII computer program, for use by the US Nuclear Regulatory Commission (NRC) in reviewing proposed onsite burials of radioactive materials by its licensees. The policy of the NRC is to review proposed onsite burial of radioactive waste on a case-by-case basis. As part of our earlier work on this project, specific human intrusion scenarios were developed that consider various potential combinations of direct exposure to penetrating radiation, inhalation of airborne radionuclides, ingestion of agricultural products raised in contaminated soil, and ingestion of radionuclides in drinking water. As a continuation of our earlier efforts, enhancements to the ONSITE/MAXII computer software package are being made that will account for additional optional shielding factors that could influence external exposure to penetrating radiation, provide options for alternative land-use conditions, and permit the user to select from a complete diet, meat diet, or vegetable diet. Additional modifications underway include (1) conversion to the ICRP 26/30 dosimetric system for assessing human exposures to radioactive materials and (2) inclusion of an optional 50-year effective committed dose equivalent calculation. The resulting computer software package will provide the necessary flexibility to conduct analyses of human-intrusion scenarios that are applicable to the terrestrial disposal of radioactive materials for a wide variety of conditions.

37596 (CONF-8509121—, pp 857-919) **Texas situation.** Avant, R.V. Jr.; Bowmer, W.J. (Texas Low-Level Radioactive Waste Disposal Authority, Austin). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Texas Low-Level Radioactive Waste Disposal Authority was formed in 1981 to address the Texas low-level radioactive waste problem consistent with the direction of P.L. 96-573. The Authority has completed technical tasks, including source term evaluations, preliminary conceptual designs, economic assessments, and long-range planning, and has work in progress on facility design, site selection, operating procedures, and licensing. Site selection has been the major technical activity and will be completed in 1987 after on-site evaluations of potential sites. The Authority expects to have its site licensed and operating in 1992. Texas has been the leader in site selection. Political concerns and the uncertainty of the national agenda led Texas policy makers to slow down the state's progress. The lessons learned through the Texas situation should be instructive to other states and compacts and may well be a prediction of events for these other groups. This paper discusses the background and status of Texas development activities, future plans, and lessons learned.

37597 **(DOE/DP/03533—T9) FY85 Program plan for the Defense Transuranic Waste Program (DTWP).** (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). Nov 1984. Contract AC04-76DP03533. 123p. NTIS, PC A06/MF A01; GPO Dep. File Number DE86011478.

The Defense TRU Waste Program (DTWP) is the focal point for the Department of Energy in national planning, integration, and technical development for TRU waste management. The scope of this program extends from the point of TRU waste generation through delivery to a permanent repository. The TRU program maintains a close interface with repository development to ensure program compatibility and coordination. The defense TRU program does not directly address commercial activities that generate TRU waste. Instead, it is concerned with providing alternatives to manage existing and future defense TRU wastes. The FY85 Program Plan is consistent with the Defense TRU Waste Program goals and objectives stated in the Defense Transuranic Waste Program Strategy Document, January 1984. The roles of participants, the responsibilities and authorities for Research and Development (R and D), the organizational interfaces and communication channels for R and D and the establishment of procedures for planning, reporting, and budgeting of all R and D activities meet requirements stated in the Technical Management Plan for the Transuranic Waste Management Program. The Program Plan is revised as needed. The work breakdown structure is reflected graphically immediately following the Administration section and is described in the subsequent narrative. Detailed budget planning (i.e., programmatic funding and capital equipment) is presented for FY85; outyear budget projections are presented for future years.

37598 **(DOE/ER/80170—T1) Device to upright fallen waste canisters at the WVDP. Final report.** Madison, F.J. II; VanSteenberg, I.M. (Madison Engineering, Reynoldsville, PA (USA)). [1986]. Contract AC01-84ER80170. 51p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86011945.

The purpose of the research conducted in this effort was to determine the feasibility of using passive mechanical means to perform uprighting of fallen canisters at the West Valley Demonstration Project. Those canisters will contain high-level radioactive waste which has been processed into its terminal form. All handling of the canisters must be done with remote facilities. The research included design of a grappling device, mathematical modeling of the device's physical characteristics, construction of a prototype, and testing of the prototype on full-scale canisters. The research demonstrated that a passive mechanical device used in conjunction with remote faciltiies located at the WVDP can grapple fallen canisters. Potential applications of this research include the use of the device for uprighting canisters at the WVDP which was the primary thrust of this research. In addition, the device may be employed for some of the routine handling tasks required at that site. Finally, the device may be useful in other facilities where remote handling of similar canisters is needed. The permanent repository for high-level radioactive waste, once it is built, may be one of the facilities which would need the device.

37599 **(DOE/ID/12449—T1) Evaluation and design of drained low-level radioactive disposal sites. Final report.** Eichholz, G.G. (ed.). (Georgia Inst. of Tech., Atlanta (USA). School of Nuclear Engineering and Health Physics). Dec 1984. Contract AS07-83ID12449. 105p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86012055.

Low-level disposal in shallow trenches has been the subject of much critical assessment in recent years. Historically most trenches have been located in fairly permeable settings and any liquid waste stored has migrated at rates limited mainly by hydraulic effects and the ion exchange capacity of underlying soil minerals. Attempts to minimize such seepage by choosing sites in very impermeable settings lead to overflow and surface runoff, whenever the trench cap is breached by subsidence or erosion. The work described in this report was directed to an optimum compromise situation where less reliance is placed on cap permanence, any ground seepage is directed and controlled, and the amount of waste leaching that would occur is minimized by keeping the soil surrounding the waste at only residual moisture levels at all times. Measurements have been conducted to determine these residual levels for some representative soils, to estimate the impact on waste migration of mainly unsaturated flow conditions, and to generate a conceptual design of a disposal facility which would provide adequate drainage to keep the waste from being exposed to continuous leaching by standing water. An attempt has also been made to quantify the reduced source terms under such periodic, unsaturated flow conditions, but those tests have not been conclusive to date. For low-permeability soils the waste should be placed about 1 ft. above the saturated layer formed by suction forces immediately above the gravel layer. Since most disposal sites, even in humid regions of the United States, are exposed only to intermittent rainfall and as most trench designs incorporate some gravel base for drainage, the results of this project have broader applications in assessing actual migration conditions in shallow trench disposal sites. Similar considerations may also apply to disposal of hazardous wastes.

37600 **(DOE/NE/44139—8) Use of a cutting and cleaning system at the West Valley Demonstration Project, March 1985-January 1986.** Wiedemann, L.W.; Standish, P.N. (Nuclear Fuel Services, Inc., West Valley, NY (USA)). Apr 1986. Contract AC07-81NE44139. 57p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012253.

This report describes the use of a commercially available ultra high pressure water cutting an cleaning system at the West Valley Demonstration Project (WVDP) Facility. This system, known as the Ultra High Pressure System (UHP), has been successfully used at the WVDP in such applications as removing concrete from the internals of a cement mixer drum, cutting conventional and high density concrete in both clean and radioactively contaminated areas of the Facility and underwater cutting of aluminum canisters previously used for storage of spent nuclear fuel assemblies. The advantages of the system include savings in manpower, reduction in radiation exposure, adaptability to remote operations, and no structural damage to surrounding materials. This report describes the equipment associated with the UHP System and the cost expected for the capital equipment, consumable materials and special tooling. Details of the various cutting and cleaning operations performed at the WVDP are provided as well as a list of future projects.

37601 **(DOE/NE/46640—16) Review and oversight of the US Department of Energy Crystalline Repository Project activities in Maine. Technical progress report, April 1, 1981-December 31, 1985.** (Maine Dept. of Conservation, Augusta (USA). Maine Geological Survey). Aug 1985. Contract FG02-81NE46640. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011851.

Specific Maine Geological Survey responses in the review and oversight of the DOE Crystalline Repository Project activities are listed. In addition to the specific activities described, the Maine Geological Survey and the Maine State Planning Office continually review information on high-level radioactive waste disposal activities within the United States and in other countries, with an emphasis on disposal in crystalline rock. The Maine Geological Survey acts as a source of information on high-level radioactive waste disposal issues for the Governor's Office, the Maine State Legislature, other state agencies, and the public.

37602 **(DOE/RW—0040-Rev.) Site descriptions: Cypress Creek, Davis Canyon, Deaf Smith, Hanford Reference, Lavender Canyon, Richton Dome, Swisher, Vacherie Dome, Yucca Mountain. Revision.** (USDOE Office of Civilian Radioactive Waste Management, Washington, DC). Apr 1986. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009983.

The following information is given about the various sites: location (state and county), terrain, climate, weather, endangered plants and animals; nearest town, population, nearest railway, nearest interstate highway, economy, density within 50 miles, owners, and historical sites. (LM)

37603 **(DP—1720) Development of the DWPF canister temporary shrink-fit seal.** Kelker, J.W. Jr. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Apr 1986. Contract AC09-76SR00001. 35p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86011912.

The Defense Waste Processing Facility is being constructed at The Savannah River Plant for the containerization of high-level nuclear waste in a wasteform for eventual permanent disposal. The waste will be incorporated in molten glass and solidified in type 304L stainless steel canisters, 2-feet in diameter x 9-feet 10-inches long, containing a flanged 6-in.-diam pipe fill-nozzle. The canisters have a minimum wall thickness of 3/8 in. Utilizing the heat from the glass filling operation, a shrink-fit seal for a plug in the end of the canister fill nozzle was developed that: will withstand the radioactive environment; will prevent the spread of contamination, and will keep moisture and water from entering the canister during storage and decontamination of the canister by wet-frit blasting to remove smearable and oxide-film fixed radioactive nuclides; is removable and can be replaced by a new oversize plug in the event the seal fails the pressure decay leakage test ($<2 \times 10^{-4}$ atm cc/sec helium); will keep the final weld closure clean and free of nuclear contamination; will withstand being pressed into the nozzle without exposing external contamination or completely breaking the seal; is reliable; and is easily installed. The seal consists of: a removable sleeve (with a tapered bore) which is shrink-fitted into the nozzle bore during canister fabrication; and a tapered plug which is placed into the sleeved nozzle after the canister is filled with radioactive molten glass. A leak-tight shrink-fit seal is formed between the nozzle, sleeve, and plug upon temperature equilibrium. The temporarily sealed canister is transferred from the Melt cell to the Decon cell, and the surface is decontaminated. Next it is transferred to the Weld/Test cell where the temporary seal is pressed down into the nozzle, revealing a clean cavity where the canister final closure weld is made.

37604 **(DP-MS—85-113) Savannah River Plant hazardous waste characterization.** Weber, D.A. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Plant). 1985. Contract AC09-76SR00001. 21p. (CONF-8510321—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86004626.

From Waste disposal by incineration symposium; Wilmington, DE, USA (22 Oct 1985).

Approximately 1780 tons of containerized hazardous waste are being stored in three buildings at the Savannah River Plant (SRP). The total amount of waste stored includes 1495 tons (84%) of organics contaminated soil from a 1984 excavation of a closed hazardous-waste landfill. To establish a database for development and design of a hazardous waste incinerator to detoxify these wastes, a waste characterization program has been developed and implemented. Approximately 1400 55-gallon drums containing hazardous waste were sampled during a three-week period in January 1985. Samples were analyzed to determine information necessary for developing an onsite waste detoxification treatment program that focuses on incineration and stabilization. Phase I analytical work was concluded in April 1985, and focused on determination of parameters such as percent, ash chemical composition and Btu content. Phase II analytical work is scheduled to be completed by November 1985 and includes: material compatibility testing, ash composition soil fusibility testing, waste detoxification testing, and Appendix VIII analyses. The total cost for both sampling and analytical work (Phase I and II) is estimated at $180,000.00.

37605 **(DP-MS—86-17) Waste salt disposal at the Savannah River Plant.** Langton, C.A.; Oblath, S.B.; Pepper, D.W.; Wilhite, E.L. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1986. Contract AC09-76SR00001. 24p. (CONF-860826—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010316.

From National meeting of the American Institute of Chemical Engineers; Boston, MA, USA (24 Aug 1986).

Waste salt solution, produced during processing of high-level nuclear waste, will be incorporated in a cement matrix for emplacement in an engineered disposal facility. Wasteform characteristics and disposal facility details will be presented along with results of a field test of wasteform contaminant release and of modeling studies to predict releases. 5 refs., 11 figs., 5 tabs.

37606 **(EGG-M—12386) Process Experimental Pilot Plant.** Henze, H. (EG and G Idaho, Inc., Idaho Falls (USA)). 1986. Contract AC07-76ID01570. 13p. (CONF-8605134—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011038.

From Interface working group on volume reduction; Savannah River, SC, USA (5 May 1986).

The Process Experimental Pilot Plant (PREPP) at the Idaho National Engineering Laboratory (INEL) was built to convert transuranic contaminated solid waste into a form acceptable for disposal at the Waste Isolation Pilot Plant (WIPP), located near Carlsbad, New Mexico. There are about 2.0 million cubic ft of transuranic waste stored at the Transuranic Storage Area of the INEL's Radioactive Waste Management Complex (RWMC). The Stored Waste Examination Pilot Plant (SWEPP) located at the RWMC will examine this stored transuranic waste to determine if the waste is acceptable for direct shipment to and storage at WIPP, or if it requires shipment to PREPP for processing before shipment to WIPP. The PREPP process shreds the waste, incinerates the shred-

ded waste, and cements (grouts) the shredded incinerated waste in new 55-gal drums. Unshreddable items are repackaged and returned to SWEPP. The process off-gas is cleaned prior to its discharge to the atmosphere, and complies with the effluent standards of the State of Idaho, EPA, and DOE. Waste liquid generated is used in the grouting operation.

37607 **(IAEA-WMRA—16-Partial) Waste management research abstracts No. 16. Information on radioactive waste programmes in progress.** (International Atomic Energy Agency, Vienna (Austria); Pacific Northwest Labs., Richland, WA (USA)). 1985. Contract AC06-76RL01830. 23p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011273.

Translation of Russian portion; summaries only.

Summaries of ten radioactive waste management research programs in the USSR are presented. (LM)

37608 **(LA—10262-M) Erosion control technology: a user's guide to the use of the Universal Soil Loss Equation at waste burial facilities.** Nyhan, J.W.; Lane, L.J. (Los Alamos National Lab., NM (USA)). May 1986. Contract W-7405-ENG-36. 74p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012765.

The Universal Soil Loss Equation (USLE) enables the operators of shallow land burial sites to predict the average rate of soil erosion for each feasible alternative combination of plant cover and land management practices in association with a specified soil type, rainfall pattern, and topography. The equation groups the numerous parameters that influence erosion rate under six major factors, whose site-specific values can be expressed numerically. Over a half century of erosion research in the agricultural community has supplied information from which approximate USLE factor values can be obtained for shallow land burial sites throughout the United States. Tables and charts presented in this report make this information readily available for field use. Extensions and limitations of the USLE to shallow land burial systems in the West are discussed, followed by a detailed description of the erosion plot research performed by the nuclear waste management community at Los Alamos, New Mexico. Example applications of the USLE at shallow land burial sites are described, and recommendations for applications of these erosion control technologies are discussed.

37609 **(ORNL/TM—9846-Vol.2) Low-level radioactive waste from commercial nuclear reactors. Volume 2. Treatment, storage, disposal, and transportation technologies and constraints.** Jolley, R.L.; Dole, L.R.; Godbee, H.W.; Kibbey, A.H.; Oyen, L.C.; Robinson, S.M.; Rodgers, B.R.; Tucker, R.F. Jr. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 377p. NTIS, PC A17/MF A01; 1; GPO Dep. File Number DE86012480.

The overall task of this program was to provide an assessment of currently available technology for treating commercial low-level radioactive waste (LLRW), to initiate development of a methodology for choosing one technology for a given application, and to identify research needed to improve current treatment techniques and decision methodology. The resulting report is issued in four volumes. Volume 2 discusses the definition, forms, and sources of LLRW; regulatory constraints affecting treatment, storage, transportation, and disposal; current technologies used for treatment, packaging, storage, transportation, and disposal; and the development of a matrix relating treatment technology to the LLRW stream as an aid for choosing methods for treating the waste. Detailed discussions are presented for most LLRW treatment methods, such as aqueous processes (e.g., filtration, ion exchange); dewatering (e.g., evaporation, centrifugation); sorting/segregation; mechanical treatment (e.g., shredding, baling, compaction); thermal processes (e.g., incineration, vitrification); solidification (e.g., cement, asphalt); and biological treatment.

37610 **(ORNL/TM—9846-Vol.3-Pt.1) Low-level radioactive waste from commercial nuclear reactors. Volume 3. Bibliographic abstracts of significant source documents. Part 1. Open-literature abstracts for low-level radioactive waste.** Bowers, M.K.; Rodgers, B.R.; Jolley, R.L. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 277p. NTIS, PC A13/MF A01; GPO Dep. File Number DE86012489.

The overall task of this program was to provide an assessment of currently available technology for treating commercial low-level radioactive waste (LLRW), to initiate development of a methodology for choosing one technology for a given application, and to identify research needed to improve current treatment techniques and decision methodology. The resulting report is issued in four volumes. Volume 3 of this series is a collection of abstracts of most of the reference documents used for this study. Because of the large volume of literature, the abstracts have been printed in two separate parts. Volume 3, part 1 presents abstracts of the open literature relating to LLRW treatment methodologies. Some of these references pertain to treatment processes for hazardous wastes that may also be applicable to LLRW management. All abstracts have been limited to 21 lines (for brevity), but each abstract contains sufficient information to enable the reader to determine the potential usefulness of the source document and to locate each article. The abstracts are arranged alphabetically by author or organization, and indexed by keyword.

37611 **(ORNL/TM—9936) Characteristics of the 3513 impoundment.** Stansfield, R.G.; Francis, C.W. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 126p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86012589.

A characterization study was conducted on a waste settling impoundment (3513 Basin) at the Oak Ridge National Laboratory, to provide information necessary for its proper disposition. The impoundment received laboratory low-level radioactive-waste waters from 1944, the year of its construction, through 1976. The pond is square-shaped and measures approximately 67 m on a side at normal water level. Water in the impoundment overlies 0.6 m of sediment waste. The current conceptual plan for impoundment closure will need to be revised to consider the following: (1) if the waste is solidified in place, remedial actions will have to be taken to isolate the solidified material from the groundwater in both the surrounding clay overburden and underlying limestone bedrock, and (2) the proposal to separate the pond into smaller workable segments by driving sheet piling into the clay may need to be modified for some parts of the pond because of an insufficiently thick clay layer in which to found the piling.

37612 **(PB—86-185410/XAB) Steady-state response of an elastic half space containing a point source of heat. Research report.** Booker, J.R.; Carter, J.P. (Sydney Univ. (Australia). School of Civil and Mining Engineering). Aug 1985. 35p. (R—497). NTIS, PC A03/MF A01.

Closed form solutions are presented for the steady-state distributions of temperature, displacement, and stress around a point source of heat embedded in a homogeneous, isotropic elastic half space. These solutions were evaluated for a typical case of a heat source buried, in rock and quantities such as the heave of the ground surface and the maximum horizontal tensile stress at the surface estimated. The results may have applications in the fields of geothermal, geotechnical, nuclear, and petroleum engineering where the soil or rock might reasonably be modelled, at least in the first instance, as a linear thermoelastic material.

37613 **(PNL—5687) Preliminary examination of the impacts of repository site characterization activities and facility construction and operation activities on Hanford air quality.** Glantz, C.S.; Ramsdell, J.V. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 74p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012082.

Air quality impacts that would result from site characterization activities and from the construction and operation of a high-level nuclear wste repository at Hanford are estimated using two

simple atmospheric dispersion models, HANCHI and CHISHORT. Model results indicate that pollutant concentrations would not exceed ambient air quality standards at any point outside the Hanford fenceline or at any publicly accessible location within the Hanford Site. The increase in pollutant concentrations in nearby communities due to site activities would be minimal. HANCHI and CHISHORT are documented in the appendices of this document. Further study of the repository's impact on air quality will be conducted when more detailed project plans and work schedules are available.

37614 **(PNL—5787) Nuclear waste treatment program. Annual report for FY 1985.** Powell, J.A. (ed.). (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 268p. NTIS, PC A12/MF A01; 1; GPO Dep. File Number DE86012161.

Two of the US Department of Energy's (DOE) nuclear waste management-related goals are: (1) to ensure that waste management is not an obstacle to the further deployment of light-water reactors (LWR) and the closure of the nuclear fuel cycle and (2) to fulfill its institutional responsibility for providing safe storage and disposal of existing and future nuclear wastes. As part of its approach to achieving these goals, the Office of Terminal Waste Disposal and Remedial Action of DOE established what is now called the Nuclear Waste Treatment Program (NWTP) at the Pacific Northwest Laboratory (PNL) during the second half of FY 1982. To support DOE's attainment of its goals, the NWTP is to provide (1) documented technology necessary for the design and operation of nuclear waste treatment facilities by commercial enterprises as part of a licensed waste management system and (2) problem-specific treatment approaches, waste form and treatment process adaptations, equipment designs, and trouble-shooting assistance, as required, to treat existing wastes. This annual report describes progress during FY 1985 toward meeting these two objectives. The detailed presentation is organized according to the task structure of the program.

37615 **(PNL—5820) Rheological evaluation of simulated neutralized current acid waste.** Fow, C.L.; McCarthy, D.; Thornton, G.T. (Pacific Northwest Labs., Richland, WA (USA)). Jun 1986. Contract AC06-76RL01830. 73p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86012633.

A byproduct of the Purex process is an aqueous waste stream that contains fission products. This waste stream, called current acid waste, is chemically neutralized and stored in double shell tanks on the Hanford Site. This neutralized current acid waste (NCAW) will be transported by pipe to B-Plant, a processing plant on the Hanford Site. Rheological and transport properties of NCAW slurry were evaluated. First, researchers conducted lab rheological evaluations of simulated NCAW. The results of these evaluations were then correlated with classical rheological models and scaled up to predict the performance that is likely to occur in the full-scale system. The NCAW in the tank will either be retrieved as is, i.e., no change in the concentration presently in the tank, or will be slightly concentrated before retrieval. Sluicing may be required to retrieve the solids. Three concentrations of simulated NCAW were evaluated that would simulate the different retrieval options: NCAW in the concentration that is presently in the tank; a slightly concentrated NCAW, called NCAW5.5; and equal parts of NCAW settled solids and water (simulating the sluicing stage), called NCAW1:1. The physical and rheological properties of three samples of each concentration at 25 and 100°C were evaluated in the laboratory. The properties displayed by NCAW and NCAW5.5 at 25 and 100°C allowed it to be classified as a pseudoplastic non-Newtonian fluid. NCAW1:1 at 25 and 100°C displayed properties of a yield-pseudoplastic non-Newtonian fluid. The classical non-Newtonian models for pseudoplastic and yield-pseudoplastic fluids were used with the laboratory data to predict the full-scale pump-pipe network parameters.

37616 **(PNL—5828) In situ vitrification large-scale operational acceptance test analysis.** Buelt, J.L.; Carter, J.G. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 52p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012215.

A thermal treatment process is currently under study to provide possible enhancement of in-place stabilization of transuranic and chemically contaminated soil sites. The process is known as in situ vitrification (ISV). In situ vitrification is a remedial action process that destroys solid and liquid organic contaminants and incorporates radionuclides into a glass-like material that renders contaminants substantially less mobile and less likely to impact the environment. A large-scale operational acceptance test (LSOAT) was recently completed in which more than 180 t of vitrified soil were produced in each of three adjacent settings. The LSOAT demonstrated that the process conforms to the functional design criteria necessary for the large-scale radioactive test (LSRT) to be conducted following verification of the performance capabilities of the process. The energy requirements and vitrified block size, shape, and mass are sufficiently equivalent to those predicted by the ISV mathematical model to confirm its usefulness as a predictive tool. The LSOAT demonstrated an electrode replacement technique, which can be used if an electrode fails, and techniques have been identified to minimize air oxidation, thereby extending electrode life. A statistical analysis was employed during the LSOAT to identify graphite collars and an insulative surface as successful cold cap subsidence techniques. The LSOAT also showed that even under worst-case conditions, the off-gas system exceeds the flow requirements necessary to maintain a negative pressure on the hood covering the area being vitrified. The retention of simulated radionuclides and chemicals in the soil and off-gas system exceeds requirements so that projected emissions are one to two orders of magnitude below the maximum permissible concentrations of contaminants at the stack.

37617 **(PNL—5864) Fiscal impacts model documentation. Version 1.0.** Beck, S.L.; Scott, M.J. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 68p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86011706.

The Fiscal Impacts (FI) Model, Version 1.0 was developed under Pacific Northwest Laboratory's Monitored Retrievable Storage (MRS) Program to aid in development of the MRS Reference Site Environmental Document (PNL 5476). It computes estimates of 182 fiscal items for state and local government jurisdictions, using input data from the US Census Bureau's 1981 Survey of Governments and local population forecasts. The model can be adapted for any county or group of counties in the United States.

37618 **(PNL—5865) Technical documentation and user's guide for City-County Allocation Model (CCAM). Version 1.0.** Clark, L.T. Jr.; Scott, M.J.; Hammer, P. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 60p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86011727.

The City-County Allocation Model (CCAM) was developed as part of the Monitored Retrievable Storage (MRS) Program. The CCAM model was designed to allocate population changes forecasted by the MASTER model to specific local communities within commuting distance of the MRS facility. The CCAM model was designed to then forecast the potential changes in demand for key community services such as housing, police protection, and utilities for these communities. The CCAM model uses a flexible on-line data base on demand for community services that is based on a combination of local service levels and state and national service standards. The CCAM model can be used to quickly forecast the potential community service consequence of economic development for local communities anywhere in the country. The remainder of this document is organized as follows. The purpose of this manual is to assist the user in understanding and operating the City-County Allocation Model (CCAM). The annual explains the data sources for the model and code modifications as well as the operational procedures.

37619 **(PNL-SA—13365) Modifying the rheological properties of melter feed for the Hanford Waste Vitrification Plant.** Blair, H.T.; McMakin, A.H. (Pacific Northwest Labs., Richland, WA (USA)). Mar 1986. Contract AC06-76RL01830. 7p. (CONF-860317—52). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011621.

From Waste management '86; Tucson, AZ, USA (2 Mar 1986).

Selected high-level nuclear wastes from the Hanford Site may be vitrified in the future Hanford Waste Vitrification Plant (HWVP) by Rockwell Hanford Company, the contractor responsible for reprocessing and waste management at the Hanford Site. The Pacific Northwest Laboratory (PNL), is responsible for providing technical support for the HWVP. In this capacity, PNL performed rheological evaluations of simulated HWVP feed in order to determine which processing factors could be modified to best optimize the vitrification process. To accomplish this goal, a simulated HWVP feed was first created and characterized. Researchers then evaluated how the chemical and physical form of the glass-forming additives affected the rheological properties and melting behavior of melter feed prepared with the simulated HWVP feed. The effects of adding formic acid to the waste were also evaluated. Finally, the maximum melter feed concentration with acceptable rheological properties was determined.

37620 **(RFP—3936) Actinide removal from nitric acid waste streams.** Muscatello, A.C.; Navratil, J.D. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1986. Contract AC04-76DP03533. 41p. (CONF-8605127—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010807.

From 10. annual actinide workshop; Los Alamos, NM, USA (12 May 1986).

Actinide separations research at the Rocky Flats Plant (RFP) has found ways to significantly improve plutonium secondary recovery and americium removal from nitric acid waste streams generated by plutonium purification operations. Capacity and breakthrough studies show anion exchange with Dowex 1x4 (50 to 100 mesh) to be superior for secondary recovery of plutonium. Extraction chromatography with TOPO(tri-n-octyl-phosphine oxide) on XAD-4 removes the final traces of plutonium, including hydrolytic polymer. Partial neutralization and solid supported liquid membrane transfer removes americium for sorption on discardable inorganic ion exchangers, potentially allowing for non-TRU waste disposal.

37621 **(RFP—3937) Chloride anion exchange process for DOR and ER residue salts.** Muscatello, A.C.; Navratil, J.D. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1986. Contract AC04-76DP03533. 35p. (CONF-8605127—2). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010803.

From 10. annual actinide workshop; Los Alamos, NM, USA (12 May 1986).

The use of a chloride anion exchange technique at Rocky Flats Plant to recover plutonium from direct oxide reduction (DOR) and electrofining (ER) residue salts is discussed. (LM)

37622 **(RFP—3962) Peats and ferrites for heavy metal removal.** Navratil, J.D. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1986. Contract AC04-76DP03533. 6p. (CONF-8604205—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010808.

From Meeting of the Society of Chemical Industry; Lancaster University, PA, USA (10 Apr 1986).

Peat is a relatively inexpensive material which processes a native cation exchange capacity. Efforts to utilize peat have been hampered by its low permeability to water and its tendency to severely leach in water at pH>6. These disadvantages have been significantly minimized by treating the peat with concentrated sulfuric acid. The acid treatment also increases the cation exchange capacity of the peat. Results of both column batch studies of the modified peat for use as an actinide adsorbent will be presented. Ferrites are mixed valence iron compounds having metal sorptive and magnetic properties. A naturally occurring ferrite material is magnetite. We have studied activation techniques to give magnetite a high capacity for removing heavy metals and actinides from aqueous process waste solutions. The solution can then be magnetically filtered to removal magnetite sorbed metals from solution. results of the experiments will be described. 18 refs.

37623 **(RFP—4013) Radioactive waste management at Rocky Flats.** Navratil, J.D. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1986. Contract AC04-76DP03533. 9p. NTIS, PC A02. File Number DE86011855.

Radioactive waste management at Rocky Flats involves the treating of process liquid wastes from the plutonium recovery areas and all other plant liquid process wastes which do not meet the requirements for on site impoundment. The treatment removes radioactive contaminants from aqueous process wastes and converts the resulting solids to a shippable form for storage off site. This paper gives a brief overview of the present production waste treatment process and provides details of a new ferrite waste treatment process presently undergoing production testing. Actinide removal and chemical properties of ferrites will be described as well as results to date of the testing of the ferrite waste treatment process.

37624 **(SAND—85-0324) Methodology for performing parallel design calculations (nuclear waste repository application).** Munson, D.E.; Morgan, H.S. (Sandia National Labs., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 104p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86012750.

In anticipation of the need to perform very high-quality design calculations for future defense high-level radioactive waste repositories in bedded salt, a methodology is proposed for the contractor selection, problem transmittal, computational quality control, and discrepancy resolution for parallel design calculations. Based on earlier findings that established the need to have at least two independent calculations of a problem to assure adequate results, a method was developed for obtaining controlled calculations. This methodology used technical monitors, peer reviews, and rigorously formal information exchange to achieve the controlled but technically independent blind solutions to the problems posed. The methodology was extensively tested through two (one heated and one unheated) well-defined boundary value problems. The report first describes the method and the details of achieving the necessary parts of the method. Then the results of the exercise involving the boundary value problem calculations are given together with the procedure of resolving the initially large discrepancies.

37625 **(SAND—85-7223) Radiochemical studies in support of the low level waste ocean disposal program (East Coast Site).** Cochran, J.K.; Hirschberg, D.J. (State Univ. of New York, Stony Brook (USA). Marine Sciences Research Center). Apr 1986. Contract AC04-76DP00789. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011995.

This report describes the final year of field work for the Low Level Waste Ocean Disposal program. The goal of the work has been to describe the extent and rates of scavenging of naturally occurring radionuclides at the Bettis east coast site. In order to characterize the extent of chemical removal of radionuclides from the oceanic water column, data are required on the partitioning between particles and solution, on the fluxes of particles (and radionuclides) through the water column, and on the amount (or inventory) of nuclide accumulated in bottom sediment at the site. This information was collected through analyses of samples taken with in situ pumps, sediment traps and gravity and box cores.

37626 **(SAND—85-7262) Computer calculations to develop quality assurance (QA) methodology for nuclear waste repository design calculations: isothermal parallel calculation. Topical report RSI-0283.** Fossum, A.F. (RE/SPEC, Inc., Rapid City, SD (USA)). Apr 1986. Contract AC04-76DP00789. 244p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE86012389.

Results are presented for the isothermal parallel calculations that were made by RE/SPEC Inc. using the finite-element computer program SPECTROM-32. These calculations were made in support of a program to develop quality assurance methodology for nuclear waste repository design calculations. The results include closures, clay seam displacements, and stress profiles for the reference repository calculation for nonheat-generating waste associated with the Sandia Waste Isolation Pilot Plant (WIPP).

37627 **(SAND—86-0244) 1985 Subseabed Disposal Project annual report: systems, October 1984-September 1985.** Klett, R.D. (Sandia National Labs., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 270p. NTIS, PC A12/MF A01; 1; GPO Dep. File Number DE86011962.

This report describes the FY85 Systems activities conducted by the Subseabed Disposal Project (SDP). Included are sediment modeling, adjoint sensitivity modeling and applications, shelf modeling, and a logistic system model for trade-off studies. Sediment, deep ocean, and Atlantic shelf sensitivity studies are presented. Ship accident data update, a barge accident analysis, a US/NEA risk analysis comparison study, and an emplacement ship functional analysis are discussed.

37628 **(SAND—86-0488) Two-dimensional axisymmetric and plane strain scoping calculations for the Small Scale Seal Performance Test, Test Series A.** Torres, T.M. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 53p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012007.

This report presents two-dimensional (2-D) axisymmetric and plane strain scoping calculations for the Small-Scale Seal Performance Test (SSSPT), Test Series A. The SSSPT is part of the Plugging and Sealing Program for the Waste Isolation Pilot Plant (WIPP) and is a precursor to future large-scale in situ experients. Test Series A is being conducted in a single isolated alcove (Room M) located in the underground salt formation; it contains several 3.66-m (12-ft)-deep vertical boreholes of varying diameters with concrete plugs of different lengths. The boreholes in Room M are instrumented for monitoring the deformation, stress, and strain resulting from the creep of the salt and the effects of the plug. Data for comparison from the experiment are not yet available. However, as a precursor to three-dimensional calculations, the 2-D axisymmetric and plane strain results presented herein are attempts to provide bounds on quantitative and qualitative structural behavioral trends for predicting the near-field response of the drift, plug, and salt.

37629 **(SAND—86-0720) Preliminary results of brine migration studies in the Waste Isolation Pilot Plant (WIPP).** Nowak, E.J. (Sandia National Labs., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 67p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012083.

Experiments to quantify brine migration in multiheater, full-scale tests simulating repository environments have been underway in the Waste Isolation Pilot Plant since April, 1985. The brine migration experiments are part of near field effects/waste package performance tests that simulate near-reference repository conditions (18 W/m^2 thermal areal loading with 470 W per canister) for defense high-level waste (DHLW) in room A1 and near-field overtest conditions (1500 W per canister) in room B. After 321 days, 22.0 kg and 19.7 kg of water had been collected from heated boreholes B041 and B042 in room B. Heated boreholes A1041 and A1042 in room A1 had yielded 1.8 kg and 1.6 kg after 162 days. These quantities of water are larger than our estimates for a hypothetical repository array of 2.16 kW canisters based on previous small scale test data and mechanistic brine transport models. They are also significantly larger than the quantities of brine that were reported for brine migration experiments in the Asse Mine of the Federal Republic of Germany. Mechanistic differences that depend on scale, thermal distribution, and site characteristics may account for this disagreement with other experiments and model calculations.

37630 **(UCRL—94600) Application of software quality assurance to a specific scientific code development task.** Dronkers, J.J. (Lawrence Livermore National Lab., CA (USA)). Mar 1986. Contract W-7405-ENG-48. 14p. (CONF-8603128—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011640.

From 17. California quality week conference; Santa Clara, CA, USA (21 Mar 1986).

This paper describes an application of software quality assurance to a specific scientific code development program. The software quality assurance program consists of three major components: administrative control, configuration management, and user documentation. The program attempts to be consistent with existing local traditions of scientific code development while at the same time providing a controlled process of development.

37631 **Evaluation of geotechnical and geohydrologic criteria for potential disposal areas.** Brinkman, J.E.; Rager, R.; Ries, K. (Sergent, Hauskins, and Beckwith, Inc., Albuquerque, NM). pp 199-208 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

Long-term stabilization of uranium mill tailings presents unique problems for geotechnical and geohydrologic siting considerations at proposed disposal sites. These include geomorphic conditions of proposed disposal sites such as erosion, river meander, and slope stability; and ground-water considerations of depth to ground water, aquifer recharge, flow, definition of background quality and other aquifer characteristics. Numerous site selection criteria are considered that are different than those used in siting industrial facilities. A formal site selection process has been developed in order to determine suitable sites for long-term stabilization of uranium mill tailings for the DOE-sponsored UMTRA Program. Key factors in this process are regional and site-specific geotechnical and geohydrologic considerations. A multi-phase approach was designed to rank selected sites according to geotechnical/-geohydrologic, engineering, and environmental considerations. This approach is presented in another paper. This paper concentrates on the detailed field investigations used to finalize the geotechnical and geohydrologic characterization of the two highest ranked sites.

37632 **Modeling flood events for long-term stability.** Schruben, T.; Portillo, R. (Jacobs Engineering Group). pp 153-162 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

The primary objective for the disposal of uranium mill tailings in the Uranium Mill Tailings Remedial Action (UMTRA) Project is isolation and stabilization to prevent their misuse by man and dispersal by natural forces such as wind, rain, and flood waters (40 CFR-192). Stabilization of sites that are located in or near flood plains presents unique problems in design for long-term performance. This paper discusses the process involved with the selection and hydrologic modeling of the design flood event; and hydraulic modeling with geomorphic considerations of the design flood event. The Gunnison, Colorado, and Riverton, Wyoming, sites will be used as examples in describing the process.

37633 **Surface geophysics at the UMTRA project site in Lakeview, Oregon.** Darr, P.; Brinkman, J.E.; Stepp, L. (Sergent, Hauskins, and Beckwith, Albuquerque, NM). pp 137-142 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

Prior to initiating an expensive drilling and testing program to determine the hydrogeologic features underlying an abandoned uranium mill tailings pile and raffinate ponds, reconnaissance level electromagnetic induction and surface electrical resistivity profiling were conducted to map apparent ground conductivity at and around the Lakeview site. Three hundred sixteen (316) electromagnetic induction measurements and twenty-eight (28) electrical resistivity measurements were obtained to prepare a conductivity map for an area of approximately 500 acres. Contouring of these geophysical measurements indicated the intensity and extent of contaminant plumes. The plume characteristics were subsequently confirmed by measurements of total dissolved solids from ground-

water samples. The design of the ground-water monitoring and hydrogeologic testing programs were based upon the results of the geophysical surveys.

37634 **Hydrologic site characterization - the UMTRA project approach.** Binkman, J.E.; Hoopes, J.R. (Sergent, Hauskins, and Beckwith, Albuquerque, NM). pp 131-136 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

The United States Environmental Protection Agency (EPA) Standards (40 CFR 192) require site characterization of the hydrogeologic regime at and around each Uranium Mill Tailings Remedial Action (UMTRA) Project site. Also, "judgements on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 CFR 32274)." To address those two sets of rules and regulations, a generic approach is being developed. Fourteen primary issues were determined. These issues can be grouped into those that can be determined by documentation of available information and present conditions, those that require extensive field investigations and those that require some form of predictive modeling. To address the various issues requires an integrated effort of hydrogeologists, environmental engineers or scientists and health physicists. In this paper, the approach to the resolution of these fourteen issues is described briefly.

37635 **An overview of the Department of Energy's program for low-level radioactive waste disposal.** Maestas, E.; Barainca, M.; Smiley, J. (Dept. of Energy, Idaho Falls, ID). pp 83-94 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—).

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

The United States National Low-Level Waste Management Program has as its objectives, the demonstration and transfer of waste management treatment and disposal technologies, and the development of the procedures to implement Section 151 of the Nuclear Waste Policy Act of 1982 for transfer of closed disposal sites to the Federal Government. In addition the program provides technical support to states and regions in the development of an effective national low-level radioactive waste management system for the disposal of waste generated in the public sector. This program follows an approach which will establish an appropriate and reliable waste management technology base to allow for a safe institutional control system. A review of the major elements of the current DOE program for low-level radioactive waste is presented along with a preview of the program direction envisioned for the coming years.

37636 **Technical database and management system (DBMS) for the UMTRA project processing sites.** Hillman, R.L.; Mohr, D.E. (Roy F. Weston Inc., West Chester, PA). pp 179-188 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

The technical DBMS is a structured and organized method for collecting, storing, retrieving, and analyzing technical data based upon standard operating procedures and quality control measures. The automated environment created by this design exists both as a repository for processing site technical data and the analysis techniques used against this data for site characterization, evaluation, and design. The system is composed of diverse technical subjects that are collectively used to address remedial action problems associated with mill tailings disposal. These technical subjects include hydrology, geology, geochemistry, radiology, and engineering.

0530 Environmental Aspects

REFER ALSO TO CITATION(S) 37608, 37629, 37631, 37636, 38882, 38886, 38908, 38951

37637 **(BNL—51955) Accelerated Leach Test(s) Program. Annual report.** Dougherty, D.R.; Fuhrmann, M.; Colombo, P. (Brookhaven National Lab., Upton, NY (USA)). Sep 1985. Contract AC02-76CH00016. 86p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012035.

This report summarizes the work performed for the Accelerated Leach Test(s) Program at Brookhaven National Laboratory in Fiscal Year 1985 under the sponsorship of the US Department of Energy's Low-Level Waste Management Program (LLWMP). Programmatic activities were concentrated in three areas, as listed and described in the following paragraphs. (1) A literature survey of reported leaching mechanisms, available mathematical models and factors that affect leaching of LLW forms has been compiled. Mechanisms which have been identified include diffusion, dissolution, ion exchange, corrosion and surface effects. Available mathematical models are based on diffusion as the predominant mechanism. Although numerous factors that affect leaching have been identified, they have been conveniently categorized as factors related to the entire leaching system, to the leachant or to the waste form. A report has been published on the results of this literature survey. (2) A computerized data base of LLW leaching data and mathematical models is being developed. The data are being used for model evaluation by curve fitting and statistical analysis according to standard procedures of statistical quality control. (3) Long-term tests on portland cement, bitumen and vinyl ester-styrene (VES) polymer waste forms are underway which are designed to identify and evaluate factors that accelerate leaching without changing the mechanisms. Results on the effect of temperature on leachability indicate that the leach rates of cement and VES waste forms increase with increasing temperature, whereas, the leach rate of bitumen is little affected.

37638 **(DOE/EIS—0115D) Process facility modifications project, Hanford Site. Draft environmental impact statement.** (USDOE Richland Operations Office, WA). Apr 1986. 240p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE86010617.

The proposed action is to construct and operate a segmentation/dissolution facility as front-end modifications (called Process Facility Modifications, or PFM) to the PUREX Plant at the Hanford Site in Washington State. The principal purpose of the proposed PFM is to permit the recovery of plutonium from the irradiated Fast Flux Test Facility (FFTF) fuel, for use in Department of Energy (DOE) Programs by preparing the fuel in the PFM for subsequent processing in the PUREX Plant. A corollary purpose is to provide an improved method of preparing irradiated fuel from DOE's N-Reactor (N-fuel) for processing in the PUREX Plant. In addition to recovering the plutonium in irradiated FFTF fuel, the proposed action would eliminate the current method of chemically decladding irradiated N-fuel and thereby reduce the radioactive liquid waste volume associated with chemical decladding; the potential environmental impacts of waste management at the Hanford Site would thereby be reduced. The proposed PFM would include the capability for cask handling, fuel storage, fuel segmentation and dissolution, and off-gas and solid waste handling. Construction is assumed to start in 1986. The PFM could be operational in 1993. The EIS includes discussion of: the PFM facility and process; quantities, composition, and disposition of process wastes; the relationship of PFM to PUREX/UO_3 Plant operations and other facilities; and analysis of the projected environmental impacts associated with the proposed action and alternatives.

37639 **(DPST—84-767) Reverse osmosis treatment of 200-area effluents.** Stimson, R.E. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 19 Sep 1984. Contract AC09-76SR00001. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011835.

Reverse osmosis testing has demonstrated sufficient decontamination factors for radionuclides and hazardous metals present in 200-area effluents (routine and accidental). Test samples included

actual process effluents, simulated effluents, and samples spiked with high activity wastes to simulate a cooling coil leak. No unusual behavior such as loss of flux or salt rejection was observed. Short term performance appears very good but membrane life and fouling tendencies will be determined only in long term testing scheduled at TNX and H-area with the 40 GPM pilot scale unit.

37640 **(LA—10573-MS) Corrective measures technology for shallow land burial at arid sites: field studies of biointrusion barriers and erosion control.** Nyhan, J.W.; Hakonson, T.E.; Lopez, E.A. (Los Alamos National Lab., NM (USA)). Mar 1986. Contract W-7405-ENG-36. 416p. NTIS, PC A18/MF A01; GPO Dep. File Number DE86012680.

The field research program involving corrective measures technologies for arid shallow land burial (SLB) sites is described. Results of field testing of a biointrusion barrier installed at a closeout waste disposal site (Area B) at Los Alamos are presented. Soil erosion and infiltration of water into a simulated trench cap with various surface treatments were measured, and the interaction between erosion control and subsurface water dynamics is discussed relative to waste management.

37641 **(MHSMP—86-17) Environmental monitoring report for Pantex Plant covering 1985.** Laseter, W.A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). 9 May 1986. Contract AC04-76DP00487. 78p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012243.

This report summarizes the environmental monitoring program at Pantex Plant for 1985. It has been prepared in accordance with the United States Department of Energy Order 5484.1. This report presents monitoring data for both radioactive and nonradioactive species in the local environment. Plant activities involve the handling of significant quantities of uranium, plutonium, and tritium. However, only small releases of depleted uranium (depleted in the isotope U-235) and tritium occurred which could have affected the local environment. Monitoring data indicate that concentrations of these nuclides in the environment are below established criteria for air and water and therefore should not present a health hazard either to employees or to the public.

37642 **(NUREG/CR—4615-Vol.1) Modeling study of solute transport in the unsaturated zone. Information and data sets. Volume 1.** Polzer, W.L.; Fuentes, H.R.; Springer, E.P.; Nyhan, J.W. (Los Alamos National Lab., NM (USA); Texas Univ., El Paso (USA). Dept. of Civil Engineering). May 1986. Contract W-7405-ENG-36. 135p. (LA—10730-MS-Vol.1). NTIS, PC A07/MF A01 - GPO. File Number TI86011926.

The Environmental Science Group (HSE-12) is conducting a study to compare various approaches of modeling water and solute transport in porous media. Various groups representing different approaches will model a common set of transport data so that the state of the art in modeling and field experimentation can be discussed in a positive framework with an assessment of current capabilities and future needs in this area of research. This paper provides information and sets of data that will be useful to the modelers in meeting the objectives of the modeling study. The information and data sets include: (1) a description of the experimental design and methods used in obtaining solute transport data, (2) supporting data that may be useful in modeling the data set of interest, and (3) the data set to be modeled.

37643 **(SAND—85-2509) Technical correspondence in support of the final environmental assessment.** Morales, A.R. (comp.). (Sandia National Labs., Albuquerque, NM (USA)). Dec 1985. Contract AC04-76DP00789. 51p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86011702.

This document is a collection of five technical memoranda and letters written to support statements in the Final Environmental Assessment for the Nevada Nuclear Waste Storage Investigations Project. The information pertains to various aspects of a high-level nuclear waste repository that may be constructed at Yucca Mountain on the Nevada Test Site.

37644 **(SAND—86-1264C) Proposal for a test problem for HYDROCOIN Level 3 Case 2. Sensitivity analysis for deep disposal in partially saturated, fractured tuff.** Prindle, R.W. (Sandia National Labs., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 41p. (CONF-860557—1). NTIS, PC A03; 3; GPO Dep. File Number DE86011645.

From 4. HYDROCOIN meeting; Tokai, Japan (26 May 1986).

Of the models that are used to assess the performance of a total repository system, those that describe the movement of groundwater at a potential repository site are especially important. The international Hydrologic Code Intercomparison Project (HYDROCOIN) was formed to evaluate hydrogeologic models and codes and their use in performance assessment for high-level radioactive waste repositories. One of the potential repository sites being evaluated by the US Department of Energy is made up of a sequence of layers of volcanic tuff. The hydrologic characteristics of the layers vary significantly because of large differences in the degree of welding, fracturing, and chemical alteration. The proposed repository horizon lies entirely within the unsaturated zone. This paper presents a proposal for a HYDROCOIN Level 3 sensitivity analysis of models that could be used to describe partially saturated flow through fractured tuff.

37645 **The effects of column dimensions on uranium mill tailings leach curves.** Martin, W.J.; Opitz, B.E.; Serne, R.J. (Pacific Northwest Lab., Richland, WA). pp 361-372 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC06-76RL01830.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

Experiments were conducted using different sized columns filled with uranium mill tailings and leached with laboratory-prepared groundwater. The data generated were used to evaluate the effects of length-to-diameter ratios on leach curves. These different column sizes and flow rates provided: 1) different solutions/solid contact times (residence times) and 2) different column volumes (scaling) and thus allowed us to address the question, Can laboratory results be scaled up to apply to real world disposal conditions? The results showed that the leach curves were similar for all the columns (no matter what the residence time or size) for all elements except chloride and calcium. The general shape of the leach curves for each constituent versus effluent volume was a rapidly decreasing curve from very high concentrations down to the groundwater concentration within about four to six pore volumes. Chloride elution was affected by mechanical dispersion, causing effluent concentrations to reach influent concentrations sooner for the columns with longer residence times. The calcium concentrations remained nearly constant or only slightly decreased over the duration of the experiments and were assumed to be controlled by the dissolution of gypsum. Aside from the chloride data, over the range of residence times and scaling factors studied, we conclude that laboratory data on uranium mill tailins leaching can be used to predict long-term movement of contaminants from actual tailings impoundments. The main reactions that control contaminant leaching from tailings are the displacement of residual mill process liquor and the redissolution of readily soluble evaporites and moderately soluble gypsum. These processes occur quite rapidly and therefore laboratory experiments with relatively short residence times are still accurate; i.e., lab residence times are long enough to transcend any short-term kinetic effects that could lead to erroneous predictions.

0540 Health And Safety

REFER ALSO TO CITATION(S) 37525, 37632, 37633, 38882, 38913, 38914, 38950

37646 (DOE/ER/60119—T3) Lung cancer epidemiology in New Mexico uranium miners. Final technical report, 1 April 1983-15 May 1986. Samet, J.M. (New Mexico Univ., Albuquerque (USA)). Jun 1986. Contract AS04-83ER60119. 38p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86011814.

This investigation assessed the health effects of radon daughter exposure in New Mexico uranium miners. Cumulative exposures sustained by earlier New mexicon miners are well below those of the Colorado Plateau; more recent miners have had even lower exposures, governed by the Federal standard of 4 working level months (WLM) annually. Cohort studies of mortality in two separate groups are in progress: a retrospective cohort study of an already selected group of 3055 miners with first underground experience before 1971; and a prospective cohort study of miners first exposed from 1971 on. For both groups, records of company physical examinations will supply mining and smoking histories. Radon daughter exposures after 1967 are available from the companies. For 1967 and earlier, they will be estimated from records of measurements made by the state. During this investigation, mortality in the cohort of earlier miners through December, 1982, will be examined. The feasibility of a large prospective cohort study of more recent miners will also be determined. Analysis of the retrospective cohort data will focus on dose-response relationships for lung cancer, interaction of cigarette smoking with radon daughter exposure in lung cancer etiology, and the occurrence of lung diseases other than cancer. Conventional cohort analysis and multivariate techniques will be used.

37647 (DOE/EV/01826—54) Uranium miner lung cancer study. Final report. Saccomanno, G. (Saint Mary's Hospital and Medical Center, Grand Junction, CO (USA)). Jun 1986. Contract AC02-76EV01826. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012321.

This study on uranium miners was started in 1957 and extended through June 30, 1986. It consisted of the routine screening of sputum from uranium miners of the Colorado Plateau, and collection of surgical and autopsy material from uranium miners who developed lung cancer. The projects resulted in: (1) Proof, for the first time, that cancer takes from 10 to 15 years to develop from the maximum accumulated carcinogenic insult and can be demonstrated through progressive cellular changes of the bronchial tree; (2) Development of a method for preserving, concentrating, and processing sputum samples. This is known as the Saccomanno Technique, and is used worldwide in diagnosing lung cancer; (3) Publication of the 1st and 2nd editions of a full-color textbook entitled "Diagnostic Pulmonary Cytology;" (4) Presentation of conclusive data on the effects of cigarette smoking and alpha progeny radiation on uranium miners, and information on safe radiation exposure levels; (5) Development of a brush-wash tube for collecting, concentrating, and preparing bronchial brushings and washings; (6) Development of cytological criteria which has improved sensitivity from 30% to about 60%; (7) Development of criteria for cytologic identification of carcinoma in situ, making it possible to diagnose lung cancer before it can be detected on chest x-ray.

37648 (DOE/OR/20722—21) Design report for the interim waste containment facility at the Niagara Falls Storage Site. (Bechtel National, Inc., Oak Ridge, TN (USA). Advanced Technology Div.). May 1986. Contract AC05-81OR20722. 210p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE86012601.

Low-level radioactive residues from pitchblende processing and thorium- and radium-contaminated sand, soil, and building rubble are presently stored at the Niagara Falls Storage Site (NFSS) in Lewiston, New York. These residues and wastes derive from past NFSS operations and from similar operations at other sites in the United States conducted during the 1940s by the Manhattan Engineer District (MED) and subsequently by the Atomic Energy Commission (AEC). The US Department of Energy (DOE), successor to MED/AEC, is conducting remedial action at the NFSS under two programs: on-site work under the Surplus Facilities Managemnt Program and off-site cleanup of vicinity properties under the Formerly Utilized Sites Remedial Action Program. On-site remedial action consists of consolidating the residues and wastes within a designated waste containment area and constructing a waste containment facility to prevent contaminant migration. The service life of the system is 25 to 50 years. Near-term remedial action construction activities will not jeopardize or preclude implementation of any other remedial action alternative at a later date. Should DOE decide to extend the service life of the system, the waste containment area would be upgraded to provide a minimum service life of 200 years. This report describes the design for the containment system. Pertinent information on site geology and hydrology and on regional seismicity and meteorology is also provided. Engineering calculations and validated computer modeling studies based on site-specific and conservative parameters confirm the adequacy of the design for its intended purposes of waste containment and environmental protection.

37649 (EPA/520/5—85-026) Environmental pathway models for estimating population health effects from disposal of high-level radioactive waste in geologic repositories. Final report. Smith, J.M.; Fowler, T.W.; Goldin, A.S. (Environmental Protection Agency, Montgomery, AL (USA). Eastern Environmental Radiation Facility). May 1986. 375p. NTIS, PC A16/MF A01. File Number TI86901474.

As part of its program to develop environmental standards for disposal of high-level radioactive wastes, the Environmental Protection Agency estimated population health risks for 10,000 years after disposal in mined geologic repositories (EPA85a). This report describes the mathematical models formulated to calculate the environmental risk commitments (ERC's - fatal cancers and serious genetic effects to all generations) that could occur as a result of releases from such repositories. The report also identifies the data chosen to use in these models and presents estimates of the premature fatal cancers caused per unit of radionuclide released to the accessible environment.

37650 (FNAL-TM—1394) Muon fluence measurements at the site boundary for 1985. Elwyn, A.J. (Fermi National Accelerator Lab., Batavia, IL (USA)). Mar 1986. Contract AC02-76CH03000. 11p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010848.

Muon fluence (muons cm^{-2}) was measured downstream of the experimental area beamlines, just beyond the Fermilab site boundary at Route 38. The purpose of these measurements was to obtain an estimate of the yearly off-site radiation exposure to the general population due to accelerator-produced muons during the 1985 800 GeV run.

37651 (GJ/TMC—11) Procedure manual for the estimation of average indoor radon-daughter concentrations using the radon grab-sampling method. George, J.L. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). Apr 1986. Contract AC07-76GJ01664. 47p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012078.

The US Department of Energy (DOE) Office of Remedial Action and Waste Technology established the Technical Measurements Center to provide standardization, calibration, comparability, verification of data, quality assurance, and cost-effectiveness for the measurement requirements of DOE remedial action programs. One of the remedial-action measurement needs is the estimation of average indoor radon-daughter concentration. One method for accomplishing such estimations in support of DOE remedial action programs is the radon grab-sampling method. This manual describes procedures for radon grab sampling, with the application specifically directed to the estimation of average indoor radon-daughter concentration (RDC) in highly ventilated structures. This particular application of the measurement method is for cases where RDC estimates derived from long-term integrated measurements under occupied conditions are below the standard and where the structure being evaluated is considered to be highly ventilated. The radon grab-sampling method requires that sampling be conducted under standard maximized conditions. Briefly, the procedure for radon grab sampling involves the following steps: selection of sampling

and counting equipment; sample acquisition and processing, including data reduction; calibration of equipment, including provisions to correct for pressure effects when sampling at various elevations; and incorporation of quality-control and assurance measures. This manual describes each of the above steps in detail and presents an example of a step-by-step radon grab-sampling procedure using a scintillation cell.

37652 **(NUREG—1179-Vol.2) Rupture of Model 48Y UF_6 cylinder and release of uranium hexafluoride. Cylinder overfill, March 12-13, 1986. Investigation of a failed UF_6 shipping container. Volume 2.** (Nuclear Regulatory Commission, Denver, CO (USA). Augmented Investigation Team). Jun 1986. 209p. NTIS, PC A10/MF A01 - GPO. File Number TI86901486.

NUREG-1179, Volume 1, reported on the rupture of a Model 48Y uranium hexafluoride (UF_6) cylinder and the subsequent release of UF_6. At the time of publication, a detailed metallurgical examination of the damaged cylinder was under way and results were not available. Subsequent to the publication of Volume 1, a second incident occurred at the Sequoyah Fuels Corporation facility. On March 13, 1986, a Model 48X cylinder was overfilled during a special one-time draining procedure; however, no release of UF_6 occurred. An Augmented Investigation Team investigated this second incident. This report, NUREG-1179, Volume 2, presents the findings made by the Augmented Investigation Team of the March 13 incident and the report of the detailed metallurgical examination conducted by Battelle Columbus Division of the cylinder damaged on January 4, 1986.

37653 **(NUREG/CR—3620-Suppl.1) Intruder dose pathway analysis for the onsite disposal of radioactive wastes: the ONSITE/MAXI1 computer program. Supplement No. 1.** Kennedy, W.E. Jr.; Peloquin, R.A.; Napier, B.A.; Neuder, S.M. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 183p. (PNL—4054-Suppl.1). NTIS, PC A09/MF A01 - GPO. File Number TI86011529.

The document entitled Intruder Dose Pathway Analysis of the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXI1 Computer Program (1984) summarizes initial efforts to develop human-intrustion scenarios and a modified version of the MAXI computer program for potential use by the NRC in reviewing applications for onsite radioactive waste disposal. This document is a supplement to that document and summarizes efforts to further modify and improve the ONSITE/MAXI1 software package. To facilitate cross-referencing, it follows the same format. Notable improvements to the software package include the capability to account for shielding conditions that represent noncompacted trash wastes and the option to indicate alternative land-use condition;s. This supplement contains a description of the implementation of these modifications. In addition, a series of discussions are included in an attempt to increase the user's understanding of the scenarios and dose calculation methods. These discussions respond to frequently asked questions about the mathematical models and use of the software. Computer listings of the ONSITE/MAXI1 computer program are included as Appendices A and B of this document. Appendix C lists external exposure dose-rate factor libraries.

37654 **(PNL—5888) EXCOMP: an exposure comparison methodology.** Lavender, J.C.; Franklin, A.L. (Pacific Northwest Labs., Richland, WA (USA)). Jun 1986. Contract AC06-76RL01830. 61p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86012222.

EXCOMP is a computerized model that was developed to project occupational exposures based on conceptual designs for the Monitored Retrievable Storage (MRS) Facility. EXCOMP was developed to identify locations and operations in the facility that have a potential for significant occupational exposure rates. Unlike the computerized models that are currently used, EXCOMP is fast and provides the analyst more analysis flexibility. The analyst has the option of evaluating the occupational exposures for an entire facility, specific work locations, personnel profiles based on employees' job descriptions, or the exposure potential of specific identified sources. Comparative analyses can be performed rapidly by initially analyzing the occupational exposures for a facility or a personnel profile and then modifying the database for selected specific work or source locations. EXCOMP was developed to provide the analyst a took that can be used to perform integrated facility evaluations of occupational and public exposures. EXCOMP provides estimates of exposure rates for the purpose of identifying areas with high exposure potential. These areas can be further evaluated using existing detailed exposure modeling computer codes or by performing "hands on" monitoring.

37655 **(PNL-SA—13541) Health effects estimation: methods and results for uranium mill tailings contaminated properties.** Denham, D.H.; Cross, F.T.; Soldat, J.K. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 18p. (CONF-860425—34). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011624.

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

This paper describes methods for esimating potential health effects from exposure to uranium mill tailings and presents a summary of risk projections for 57 contaminated properties (residences, schools, churches, and businesses) in the United States. The methods provide realistic estimates of cancer risk to exposed individuals based on property-specific occupancy and contamination patterns. External exposure to gamma radiation, inhalation of radon daughters, and consumption of food products grown in radium-contaminated soil are considered. Most of the projected risk was from indoor exposure to radon daughters; however, for some properties the risk from consumption of locally grown food products is similar to that from radon daughters. In all cases, the projected number of lifetime cancer deaths for specific properties is less than one, but for some properties the increase in risk over that normally expected is greater than 100%.

37656 **(SAND—85-2206C) Projected environmental impacts of radioactive material transportation to the first US repository site.** Neuhauser, K.S.; Cashwell, J.W.; Reardon, P.C.; Ostmeyer, R.M.; McNair, G.W. (Sandia National Labs., Albuquerque, NM (USA); Pacific Northwest Labs., Richland, WA (USA)). 1986. Contract AC06-76RL01830;AC04-76DP00789. 10p. (IAEA-SM—286/88; CONF-860604—22). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011647.

From International symposium on the packaging and transport of radioactive materials (PATRAM '86); Davos, Switzerland (16 Jun 1986).

This paper discusses the relative national environmental impacts of transporting nuclear wastes to each of the nine candidate repository sites in the United States. Several of the potential sites are closely clustered and, for the purpose of distance and routing calculations, are treated as a single location. These are: Cypress Creek Dome and Richton Dome in Mississippi (Gulf Interior Region), Deaf Smith County and Swisher County sites in Texas (Permian Basin), and Davis Canyon and Lavender Canyon site in Utah (Paradox Basin). The remaining sites are: Vacherie Dome, Louisiana; Yucca Mountain, Nevada; and Hanford Reservation, Washington. For compatibility with both the repository system authorized by the NWPA and with the MRS option, two separate scenarios were analyzed. In belief, they are (1) shipment of spent fuel and high-level wastes (HLW) directly from waste generators to a repository (Reference Case) and (2) shipment of spent fuel to a Monitored Retrievable Storage (MRS) facility and then to a repository. Between 17 and 38 truck accident fatalities, between 1.4 and 7.7 rail accident fatalities, and between 0.22 and 12 radiological health effects can be expected to occur as a result of radioactive material transportation during the 26-year operating period of the first repository. During the same period in the United States, about 65,000 total deaths from truck accidents and about 32,000 total deaths from rail accidents would occur; also an estimated 58,300 cancer fatalities are predicted to occur in the United States during a 26-year period from exposure to background radiation alone (not including medical and other manmade sources). The risks reported here are upper limits and are small by comparison with the "natural background" of risks of the same type. 3 refs., 6 tabs.

37657 **(UNI-SA—169) US DOE surplus facilities management program (SFMP). International technology exchange activities.** Broderick, J. . (UNC Nuclear Industries, Inc., Richland, WA (USA)). 1986. Contract AC06-76RL01857. 8p. (CONF-8603124—1-Summ.). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010607.

From 4. meeting DOE/PNC joint working group on waste management; Richland, WA, USA (10 Mar 1986).

The Surplus Facilities Management Program is one of five remedial action programs established by the US Department of Energy (DOE) to eliminate potential hazards to the public and environment from radioactive contamination. These programs provide remedial actions at various facilities and sites previously used by the US Government in national atomic energy programs. Included are uranium ore milling sites, nuclear materials production plants, and research and development facilities. The DOE's five remedial action programs are: the Grand Junction Remedial Action Project; the Formerly Utilized Sites Remedial Action Project; the West Valley Demonstration Project; and the Surplus Facilities Management Program. The Surplus Facilities Management Program (SWMP) was established by DOE in 1978. There are presently over 300 shutdown facilities in the SFMP located at sites across the United States and in Puerto Rico. In some cases, remedial action involves decontaminating and releasing a facility for some other use. In other instances, facilities are completely demolished and removed from the site.

37658 **Material transport models for accident-induced flow in nuclear fuel cycle facilities.** Greenaugh, K.C. (Nuclear Regulatory Commission, Washington, DC). *Transactions of the American Nuclear Society;* 50: 465(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Assessment of the environmental consequences of an accident in a fuel cycle facility ultimately involves calculating the atmospheric dispersion of radioactive materials and estimating the radiation dose to the surrounding population. Some uncertainty lies in the estimate of the nuclear facility source term to be used for atmospheric dispersion calculations. The developed models can be incorporated into a code that predicts the gas dynamics induced from fire, explosions, or tornado accidents to better estimate the source term at the atmospheric boundary of a nuclear fuel cycle facility.

37659 **Groundwater modeling for uranium mill tailings sites.** Deb, A.; Colarullo, S.; Snyder, J. (Roy F. Weston, Inc., West Chester, PA). pp 391-400 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

There are 25 designated inactive uranium mill tailing sites in the nation. Recognizing the fact that these sites may pose a potential health hazard to the public, the Congress passed The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), which provides the Environmental Protection Agency with the responsibility for promulgating radiological and nonradiological standards for inactive mill sites. EPA established standards which require long-term stability with a design objective of 1000 years. The U.S. Department of Energy has been authorized to administer the Uranium Mill Tailings Remedial Action Program (UMTRAP) in order to address the problem of uranium mill tailings disposal sites. These sites have several significant environmental impacts which include surface emission of gamma radiation and radon gas, and potential contamination of ground water by radionuclides leached from the tailings. Engineering solutions to mitigate these impacts involve encapsulating and/or covering the tailings pile. The cover is designated to act as a barrier to moisture penetration and to reduce surface emissions of gamma radiation and radon gas. For further protection a liner can be included to intercept any leachate that may have formed.

37660 **Radiological characterization requirements for planning remedial action at UMTRA project sites.** Zelle, P.W.; Schoenfelder, R.P.; Baker, K.R. (Roy F. Weston Inc., Albuquerque, NM). pp 243-254 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

Twenty-four inactive uranium processing sites are designated for remedial action under the Uranium Mill Tailings Remedial Action (UMTRA) Project. An extensive radiological site characterization effort is underway to obtain the data necessary to design the remedial action. This includes data for determining the pile radium-226 content and distribution, the radon emanating fraction of tailings, the radon diffusion coefficients of tailings and cover material, and the contaminant distribution in former processing areas and nearby areas contaminated by wind or water transport. The radium-226 content of the piles is determined by gamma spectroscopy analyses of core samples taken from holes drilled at a density of approximately one per acre. For open lands adjacent to the pile, gamma-ray exposure rate measurements are made to delineate the approximate boundary of the off-pile contamination. A combination of gamma-ray downhole-logging, soil sampling, and in-situ gamma analyses techniques are used to carefully define the depth and areal extent of the contamination. Two different plans exist for surveying buildings, one plan for structures to be demolished, and another for those to be decontaminated. For building surveys, measurements are taken for surface alpha contamination, gamma-ray exposure rate, and radon daughter concentration. All data are recorded relative to a reproducible reference grid that spans the tailings pile, buildings, and nearby open lands. The details of the development and implementation of the radiological characterization plan for off-pile contamination are presented.

37661 **Alternate site selection process for the UMTRA project site in Lakeview, Oregon.** Taber, W.N.; Lechel, D.J. (Roy F. Weston, Inc., Albuquerque, NM). pp 221-232 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

The object of this study was to develop and implement an alternate site selection process for remedial actions at the Lakeview, Oregon, Uranium Mill Tailings Remedial Action (UMTRA) Project site. Requiring an alternate disposal site suitable for permanent (200-1,000 years) storage of tailings and other wastes, a four phased approach was implemented to evaluate and select two suitable sites. Phase I, Designation of a Search Region, identified criteria for selecting an initial study area and a minimum area to satisfy these criteria. A study area of approximately 700 square miles resulted from the Phase I effort. Phase II, Preliminary Screening of the Designated Search Region, established geotechnical and environmental guidelines (Regional Screening Guidelines) to eliminate areas within the study area that were considered unsuitable for uranium tailings disposal. Application of the guidelines developed for Phase II reduced the study area from 700 square miles to approximately 70 square miles. Phase III, Preliminary Screening and Evaluation of Potential Areas, developed criteria considered desirable in selecting potential disposal sites and applied these criteria in the selection of six alternate areas. Results of this phase reduced the study area from 70 square miles to seven square miles. Phase IV, Identification and Evaluation of Candidate Sites, selected specific 40 acre parcels, developed a detailed rating matrix for each site, and ranked the selected sites in terms of overall suitability. The development of the site selection process and the application of the developed evaluation techniques are presented with the results of the program.

37662 **Pathways analyses and their role in the decision making process for selection of low-level waste disposal sites.** Pin, F.G.; Oblow, E.M. (Oak Ridge National Lab., Oak Ridge, TN). pp 115-124 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—).

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

Pathways analyses have been extensively used to evaluate the suitability of proposed sites for disposal of low-level radioactive waste. The analyses rely on conservative scenarios to describe potential human exposure to the waste. Conceptual and numerical models are used to simulate the long-term transport of contamination to man and additional conservatism generally is built into the analysis when assumptions concerning future events have to be made or when uncertainties concerning site or waste characteristics exist. This conservatism is useful in ascertaining whether the site provides an adequate buffer to persons outside the site boundary. In reaching conclusions concerning site capacity and site acceptability, however, condiderations must be given to the uncertainities involved in the analysis. Analytical methods to quantitatively assess the sensitivity of the results to data uncertainties may prove useful in the decision making process for site suitability.

37663 **The current status of the Uranium Mill Tailings Remedial Actions Project.** Matthews, M.L. (Dept. of Energy, Albuquerque, NM). pp 125-130 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—).

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

In late 1978, Congress enacted Public Law 96-604, the "Uranium Mill Tailings Radiation Control Act of 1978." The Act instructed the Department of Energy to perform remedial actions at designated inactive uranium mill tailings sites. DOE established the Uranium Mill Tailings Remedial Actions (UMTRA) Project Office to implement remedial actions at the sites, in cooperation with the affected States, Indian tribes, Nuclear Regulatory Commission, and owners of the sites in 1983, with an additional site started in late 1984, and two more planned in 1985. Numerous vicinity properties at four different site areas are also presently being cleaned up. All of this work is being performed in accordance with Environmental Protection Agency cleanup standards.

37664 **Geotechnical engineering considerations in the NRC's review of uranium mill tailings remedial action plans.** Gillen, D.M. (Div. of Waste Management, U.S. Nuclear Regulatory Commission, Washington, DC). pp 13-22 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—).

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

To reduce potential health hazards associated with inactive uranium mill tailings sites, the Department of Energy (DOE) is presently investigating and implementing remedial actions at 24 sites in the Uranium Mill Tailings Remedial Action Program (UMTRAP). All remedial actions must be selected and performed with the concurrence of the Nuclear Regulatory Commission (NRC). This paper provides a discussion of geotechnical engineering considerations during the NRC's preconcurrence review of proposed remedial action plans. In order for the NRC staff to perform an adequate geotechnical engineering review, DOE documents must contain a presentation of the properties and stability of all in-situ and engineered soil and rock which may affect the ability of the remedial action plans to meet EPA standards for long-term stability and control. Site investigations, laboratory testing, and remedial action designs must be adequate in scope and technique to provide sufficient data for the NRC staff to independently evaluate static and dynamic stability, settlement, radon attenuation through the soil cover, durability of rock for erosion protection, and other geotechnical engineering factors.

0550 Regulations

REFER ALSO TO CITATION(S) 37513, 37536, 37559, 37564, 37565, 37567, 37575, 37576, 37578, 37589, 38471

37665 (CONF-8509121—, pp 22-36) **Overview of EPA's Low-Level Radioactive Waste Standards development program, 1985.** Meyer, G.L.; Galpin, F.L.; Gruhlke, J.M. (Environmental Protection Agency, Washington, DC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Environmental Protection Agency is continuing development of generally applicable environmental standards for land disposal of low-level radioactive wastes (LLW) under authority of the Atomic Energy Act. EPA's effort also includes: determining whether some LLW wastes contain sufficiently low levels of radioactivity to be Below Regulatory Concern (BRC) regarding radioactive hazard, and covering certain natural and accelerator-produced radioactive materials under LLW Standards, using Resource Conservation and Recovery Act 1976 authority. This paper reports the current status of EPA's LLW Standards program, including: status of assessment model development and testing; Science Advisory Board review; revisions to LLW source terms used, with special attention to C-14; addition to those alternatives assessed of two new disposal methods and long-term engineered surface storage; information on source term and risk assessments performed for NARM portion of the standard; additional risk assessments conducted for LLW and BRC waste types; and revised LLW standards schedule. 24 references, 3 tables.

37666 (CONF-8509121—, pp 37-40) **Future directions for the US Nuclear Regulatory Commission's low-level waste management program.** Starmer, R.J. (Nuclear Regulatory Commission, Washington, DC). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The Low-Level Radioactive Waste Policy Act envisioned that all states would be able to dispose of commercial low-level waste generated within their borders by 1986, either individually or through interstate compacts. Based on the current status of state and compact efforts, it is clear that no new disposal sites will be available by 1986 or for some period thereafter. In the short-term, there is uncertainty that the existing disposal sites will remain open after January 1, 1986, or if restrictions will apply after that time. If restrictions occur, storage, treatment or even curtailed generation may result for individual waste producers. Other uncertainties clouding implementation of the Policy Act include the final configuration of regional compacts - in the northeast in particular - clear assignment of responsibility for disposal of classes of waste, the method of disposal - shallow land burial or alternatives - that will be employed for low-level waste, and regulation of mixed wastes, wastes which have both radioactive and non-radioactive hazardous constituents. The NRC strategy for low-level waste management aims to resolve or reduce these uncertainties, and to encourage transition to a stable, national system based on timely state action. NRC will continue development of regulatory and technical guidance for disposal site licensing and build on its capabilities to address specific areas of state concern, such as alternatives to shallow land burial, and site characterization and modeling. NRC also plans to expand state and compact outreach efforts to help ensure that our technical work is properly focused. The authors will also be directly assisting those states and compacts on technical matters they confront in actual disposal site development and licensing.

37667 (CONF-8509121—, pp 342-353) **Update of Part 61 impacts analysis methodology.** Oztunali, O.I.; Roles, G.W. (Envirosphere Co.). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The US Nuclear Regulatory Commission is expanding the impacts analysis methodology used during the development of the 10 CFR Part 61 rule to allow improved consideration of costs and

impacts of disposal of waste that exceeds Class C concentrations. The project includes updating the computer codes that comprise the methodology, reviewing and updating data assumptions on waste streams and disposal technologies, and calculation of costs for small as well as large disposal facilities. This paper outlines work done to date on this project.

37668 (CONF-8509121—, pp 354-364) **EG & G presentation impact of resource conservation and recovery act on low-level disposal sites and the regional compact system.** Scoville, J.J. (US Ecology, Inc.). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

The dual regulation of the commercial low-level radioactive waste sites could cause a disruption of the national system for waste disposal and delay in the siting and construction of new facilities. A resolution of this situation may be forthcoming from Congress in the form of an amendment to the Low-Level Waste Policy Act of 1980.

37669 (CONF-8509121—, pp 617-631) **Pad A - an exercise in site stabilization.** Brown, R.M. (EG & G Idaho, Inc., Idaho Falls). Feb 1986. NTIS, PC A99/MF A01. File Number DE86010152.

From 7. annual DOE LLWMP participants information meeting; Las Vegas, NV, USA (10 Sep 1985).

Federal regulations, Department of Energy (DOE) Order 5820.2, and Title 10, Code of Federal Regulations, Part 61 (10 CFR 61), require approved stabilization and closure plans for all new and existing shallow-land radioactive waste burial sites. To prepare a closure plan for the Subsurface Disposal Area (SDA) at the Idaho National Engineering Laboratory (INEL), additional technology development was considered necessary. Pad A, an above grade inactive buried waste area within the SDA at the INEL, has been selected as a stabilization demonstration site to provide operational and developmental technology. This paper discusses the Pad A waste characterization, disposal configuration, and proposed compaction and barrier cover methodology. Since Pad A contains radioactive mixed waste, evaluation of the proposed demonstration as it relates to DOE Order 5480.14, Comprehensive Environmental Response Compensation and Liability Act (CERCLA) is briefly discussed. Also briefly discussed are the Federal regulations requiring stabilization and closure. Issues addressed include radiological, safety, and environmental concerns and risks encountered to date.

37670 (LA-UR—86-1394) **Sequential analysis of materials balances. Application to a prospective reprocessing facility.** Picard, R. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 15p. (CONF-8605130—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010196.

From Bilateral technical workshop on NRTMA; Hannover, F.R. Germany (5 May 1986).

This paper discusses near-real-time accounting in the context of the prospective DWK reprocessing plant. Sensitivity of a standard sequential testing procedure, applied to unfalsified operator data only, is examined with respect to a variety of loss scenarios. It is seen that large inventories preclude high-probability detection of certain protracted losses of material. In Sec. 2, a rough error propagation for the MBA of interest is outlined. Mathematical development for the analysis is given in Sec. 3, and generic aspects of sequential testing are reviewed in Sec. 4. In Sec. 5, results from a simulation to quantify performance of the accounting system are presented.

37671 (LA-UR—86-2032) **Materials accounting system for an IBM PC.** Bearse, R.C.; Thomas, R.J.; Henslee, S.P.; Jackson, B.G.; Tracy, D.B.; Pace, D.M. (Los Alamos National Lab., NM (USA); Argonne National Lab., Idaho Falls, ID (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-860654—23). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012371.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

We have adapted the Los Alamos MASS accounting system for use on an IBM PC/AT at the Fuels Manufacturing Facility (FMF) at Argonne National Laboratory-West (ANL-WEST) in Idaho Falls, Idaho. Cost of hardware and proprietary software was less than $10,000 per station. The system consists of three stations between which accounting information is transferred using floppy disks accompanying special nuclear material shipments. The programs were implemented in dBASEIII and were compiled using the proprietary software CLIPPER. Modifications to the inventory can be posted in just a few minutes, and operator/computer interaction is nearly instantaneous. After the records are built by the user, it takes 4 to 5 seconds to post the results to the database files. A version of this system was specially adapted and is currently in use at the FMF facility at Argonne National Laboratory in Idaho Falls. Initial satisfaction is adequate and software and hardware problems are minimal.

37672 (LA-UR—86-2088) **Quality assurance for IAEA inspection planning.** Markin, J.T. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 6p. (CONF-860654—14). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012411.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

Under the provisions of the Treaty on Nonproliferation of Nuclear Weapons and other agreements with states, the International Atomic Energy Agency (IAEA) conducts inspections at nuclear facilities to confirm that their operation is consistent with the peaceful use of nuclear material. The Department of Safeguards at the IAEA is considering a quality assurance program for activities related to the planning of these facility inspections. In this report, we summarize recent work in writing standards for planning inspections at the types of facilities inspected by the IAEA. The standards specify the sequence of steps in planning inspections, which are: (1) administrative functions, such as arrangements for visas and travel, and communications with the state to confirm facility operating schedules and the state's acceptance of the assigned inspectors; (2) technical functions including a specification of the required inspection activities, determination of personnel and equipment resources, and a schedule for implementing the inspection activities at the facility; and (3) management functions, such as pre- and post-inspection briefings, where the planned and implemented inspection activities are reviewed.

37673 (LA-UR—86-2099) **Facility model for the Los Alamos Plutonium Facility.** Coulter, C.A.; Thomas, K.E.; Sohn, C.L.; Yarbro, T.F.; Hench, K.W. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-860654—15). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012409.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

The Los Alamos Plutonium Facility contains more than sixty unit processes and handles a large variety of nuclear materials, including many forms of plutonium-bearing scrap. The management of the Plutonium Facility is supporting the development of a computer model of the facility as a means of effectively integrating the large amount of information required for material control, process planning, and facility development. The model is designed to provide a flexible, easily maintainable facility description that allows the faciltiy to be represented at any desired level of detail within a single modeling framework, and to do this using a model program and data files that can be read and understood by a technically qualified person without modeling experience. These characteristics were achieved by structuring the model so that all facility data is contained in data files, formulating the model in a simulation language that provides a flexible set of data structures and permits a near-English-language syntax, and using a description for unit processes that can represent either a true unit process or a major subsection of the facility. Use of the model is illustrated by applying it to two configurations of a fictitious nuclear material processing line.

37674 (LA-UR—86-2108) **Learning to live with holdup.** Pillay, K.K.S.; Picard, R.R. (Los Alamos National Lab., NM (USA)). Jun 1986. Contract W-7405-ENG-36. 7p. (CONF-860654—17). NTIS, PC A02/MF A01 - GPO. File Number TI86012408.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

Holdup of special nuclear materials in processing facilities is recognized by facility operators and regulatory agencies as an insidious materials control and accounting problem. However, there have been few serious efforts to address holdup as a materials accounting problem and to accommodate the legitimate concerns of both groups. This paper reviews past efforts and identifies several key elements relevant to resolving the problem in a pragmatic fashion. These key elements relate to the recognition of holdup as a serious materials accounting problem, innovations in holdup monitoring and their limitations, the role of modeling and sampling in holdup estimation, and the potential value of plant-specific materials accountability requirements. Suggestions are offered for developing cost-effective procedures for holdup measurements/estimation, combining available technologies with properly designed sampling plans.

37675 **(LA-UR—86-2122) Nuclear materials accounting, helping the facility operator.** Barnes, J.W.; Thomas, K.E. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 9p. (CONF-860654—11). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012405.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

A modern materials control and accounting (MC and A) system can provide major benefits to production personnel. It can enhance understanding of process systems performance, localize and reconcile material losses, and identify instruments that are out-of-calibration or malfunctioning. Examples of the above MC and A system applications are given. We show how Operations personnel can use an MC and A system to their advantage rather than letting the MC and A system take advantage of them.

37676 **(LA-UR—86-2187) Use of storage tank holdup measurements to reduce inventory differences in an ion exchange process.** Bonner, C.A.; Marshall, R. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 4p. (CONF-860654—22). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012438.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

Inventory differences (ID) in an ion exchange process area have plagued the Los Alamos National Laboratory for years. The problem has always been attributed to plutonium precipitation in banks of horizontally oriented storage tanks; however, efforts to maintain the precipitates at low enough or even stable levels failed. Factoring tank holdup measurements into the end-of-month inventory balance would probably solve the ID problem; however, the authors were advised that gamma-based holdup measurements would yield very poor quality holdup estimates because of difficulties in determining transmission corrections and tank "cross talk." When the ID problem became particularly troublesome in the spring of 1985, the authors evaluated two different gamma-based measurement techniques for estimating tank holdup. Not only did holdup estimates made by the two techniques agree, but plutonium recovered during intensive tank cleanout confirmed that the holdup measurements were of sufficient accuracy to be used for material balance adjustments. The measurement method chosen for routine use is somewhat unique since it is calibrated using tank cleanout data and requires no transmission corrections. The holdup measurements are made on a monthly basis and have dramatically reduced end-of-month inventory differences. This paper will present both a description of the measurement methodology and the inventory difference improvements.

37677 **(LA-UR—86-2189) Mobile nondestructive assay and examination instruments.** Bieri, J.M.; Caldwell, J.T.; Audas, J.H.; Butterfield, K.B.; France, S.W.; Garcia, C. Jr.; Hastings, R.D.; Herrera, G.C.; Kuckertz, T.H.; Kunz, W.E. (Los Alamos National Lab., NM (USA); EG and G, Inc., Goleta, CA (USA). Santa Barbara Operations). 1986. Contract W-7405-ENG-36. 15p. (CONF-860654—25). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012437.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

A compact system that evaluates radioactive materials can furnish a big savings to taxpayers by ensuring that only properly identified nuclear waste is sent to a Department of Energy (DOE) radioactive waste storage area. The Los Alamos National Laboratory's Advanced Nuclear Technology Group has developed and field tested two eaily transportable, self-contained modules: one x-rays the contents of special 208-l shipment containers, the other assays the contents. The assay and evaluation system is a simple, portable solution to a complex problem that ensures that only properly packaged transuranic (TRU) wste is shipped to the Department of Energy's Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. Caustic chemicals, liquids, and other objects or materials tht could cause a container leak during shipment are the objects of an x-ray and video camera used in the system. The camera inspects the contents of 208-l drums that are brought into the system on a conveyor and rotated, one at a time, in front of the x-ray source. Free liquids can be detected by shaking the drum; the sloshing liquid is visible on the video screen. After the drum is x-rayed, it is conveyed to the assay module where precision instruments measure the amounts of TRU isotopes present in the waste. If the drum contains fissile TRU isotopes above the safety limit, it is rejected and sent to an appropriate facility for repackaging; if the drum contains less than the 100 nCi/g lower-level limit for TRU, it is rejected and sent to a low-level nuclear waste burial site. Drums whose contents fall between these limits are accepted and certified for shipment to the WIPP. Made to fit on flatbed trailers, the entire system can be transported to a DOE facility and be ready for operations within 5 hours after arrival.

37678 **(LA-UR—86-2282) LAVA: a conceptual framework for automated risk assessment.** Smith, S.T.; Brown, D.C.; Erkkila, T.H.; FitzGerald, P.D.; Lim, J.J.; Massagli, L.; Phillips, J.R.; Tisinger, R.M. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 5p. (CONF-860654—21). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012420.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

At the Los Alamos National Laboratory we are developing the framework for generating knowledge-based systems that perform automated risk analyses on an organization's assets. An organization's assets can be subdivided into tangible and intangible assets. Tangible assets include facilities, materiel, personnel, and time, while intangible assets include such factors as reputation, employee morale, and technical knowledge. The potential loss exposure of an asset is dependent upon the threats (both static and dynamic), the vulnerabilities in the mechanisms protecting the assets from the threats, and the consequences of the threats successfully exploiting the protective systems vulnerabilities. The methodology is based upon decision analysis, fuzzy set theory, natural-language processing, and event-tree structures. The Los Alamos Vulnerability and Risk Assessment (LAVA) methodology has been applied to computer security. LAVA is modeled using an interactive questionnaire in natural language and is fully automated on a personal computer. The program generates both summary reports for use by both management personnel and detailed reports for use by operations staff. LAVA has been in use by the Nuclear Regulatory Commission and the National Bureau of Standards for nearly two years and is presently under evaluation by other governmental agencies. 7 refs.

37679 **(NBL—315) DOE research and development report. Progress report, October 1984-September 1985.** (USDOE New Brunswick Lab., NJ). Apr 1986. 88p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012193.

This report summarizes the mission activities of the New Brunswick Laboratory (NBL) of the US Department of Energy. NBL's mission is to provide and maintain a nuclear material measurements and standards laboratory as a technical extension of federal programmtic responsibilities to assure the application of accurate and reliable measurement technology for the safeguarding of special nuclear materials.

37680 **(PNL-SA—13897) Comparing corrective actions with anomaly resolution.** Smith, B.W.; Harms, N.L. (Pacific Northwest Labs., Richland, WA (USA)). Jun 1986. Contract AC06-76RL01830. 6p. (CONF-860654—19). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012146.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

Quality control and assurance are essential to any system to safeguard nuclear materials. Formalization of quality assurance activities for safeguards under the name of quality assurance has begun at several organizations. The approach to quality assurance for safeguards differs from quality assurance for facilities and hardware both in the definition and use of the product, which is information. Anomaly resolution is comparable to corrective actions in quality assurance of a hardware product, but is also part of the product of safeguards and, therefore, has its own quality assurance. This paper reviews corrective actions as compared to anomaly resolution.

37681 **(SAND—84-1439) Integrated Monitoring System (IMS) development and demonstration activities: summary of POTAS Task E.45.** Fienning, W.C.; McKnight, R.P. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012085.

The development of the Integrated Monitoring System, which monitors the shipment of spent fuel from light water reactors to reactor or away-from-reactor storage sites, is described. The system uses a crane location monitor and gamma radiation detectors to determine the arrival or departure of spent fuel loaded in shipping casks. The system records the information in a tamper-detecting, tamper-resistant enclosure for later inspection and triggers a camera for photographic assessment of anomalies.

37682 **(SAND—86-0653C) Development of a self-navigating mobile interior robot application as a security guard/sentry.** Klarer, P.R.; Harrington, J.J. (Sandia National Labs., Albuquerque, NM (USA)). Jul 1986. Contract AC04-76DP00789. 15p. (CONF-860654—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012176.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

This paper describes a mobile robot system designed to function as part of an overall security system at a high security facility. The features of this robot system include specialized software and sensors for navigation without the need for external locator beacons or signposts, sensors for remote imaging and intruder detection, and the ability to communicate information either directly to the electronic portion of the security system or to a manned central control center. Other desirable features of the robot system include low weight, compact size, and low power consumption. The robot system can be operated either by remote manual control, or it can operate autonomously where direct human control can be limited to the global command level. The robot can act as a mobile remote sensing platform for alarm assessment or roving patrol, as a point sensor (sentry) in routine security applications, or as an exploratory device in situations potentially hazardous to humans. This robot system may also be used to "walk-test" intrusion detection sensors as part of a routine test and maintenance program for an interior intrusion detection system. The hardware, software, and operation of this robot system will be briefly described herein.

37683 **(SAND—86-0654C) Subtractive approach to interior intrusion detection system design.** Sons, R.J.; Graham, R.H. Jr. (Sandia National Labs., Albuquerque, NM (USA)). 1 Jul 1986. Contract AC04-76DP00789. 12p. (CONF-860654—9). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012177.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

The subtractive approach to interior intrusion detection system design assumes that all sensors are viable candidates until they are subjected to the constraints imposed by a particular facility. The constraints are determined by a sequence of questions concerning parameters such as threat definition, facility description and operation, environment, assets to be protected, security system capabilities, and cost. As a result of the questioning, some sensors will be eliminated from the candidate list, and the "best" set of sensors for the facility will remain. This form of questioning could be incorporated into an expert system aiding future intrusion detection system designs.

37684 **(SAND—86-0655C) Sandia's experience in designing and implementing integrated high security physical protection systems.** Caskey, D.L. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 10p. (CONF-860654—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011816.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

As DOE's lead laboratory for physical security, Sandia National Laboratories has had a major physical security program for over ten years. Activities have ranged from component development and evaluation, to full-scale system design and implementation. This paper presents some of the lessons learned in designing and implementing state-of-the-art high security physical protection systems for a number of government facilities. A generic system design will be discussed for illustration purposes. Sandia efforts to transfer technology to industry will be described.

37685 **(SAND—86-0662C) Future role of AI/Robotics in physical security.** Jacobs, J. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1986. Contract AC04-76DP00789. 6p. (CONF-860654—27). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011650.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

Manpower requirements for physical security systems place a heavy burden on operating security budgets. Technology innovations which free personnel or which make security personnel more efficient in carrying out their tasks is an important means of dealing with budget and manpower constraints. It is believed that AI/Robotics will be important technologies to alleviate these problems in the future. There are three types of applications for AI and Robotics technology that may: (1) help security personnel perform their tasks more effectively or efficiently, (2) perform tasks that security personnel would otherwise perform (free up people), and (3) perform tasks that cannot be performed by security personnel at this time. This paper will discuss the various types of security applications that are presently being considered for the above areas and will briefly describe a few examples of the application of this technology. Examples will include ground mobile platforms carrying alarm assessment and/or surveillance sensors and operating either autonomously or with telepresence by a remote operator. An airborne platform performing similar functions will also be discussed. An application of a type of robot sentry that would be fixed and incorporate very simple portable displays will also be described. A third type of robot, an interior robot, that could be used in sensitive or hazardous areas to do detection and assessment functions will be reviewed.

37686 **(SAND—86-0693C) Advances in software development for intelligent interfaces for alarm and emergency management consoles.** Moseley, M.R.; Olson, C.E. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 9p. (CONF-860654—20). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012171.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

Recent advances in technology allow features like voice synthesis, voice and speech recognition, image understanding, and intelligent data base management to be incorporated in computer driven alarm and emergency management information systems. New software development environments make it possible to do rapid prototyping of custom applications. Three examples using these technologies are discussed. (1) Maximum use is made of high-speed graphics and voice synthesis to implement a state-of-the-art alarm processing and display system with features that make the operator-machine interface efficient and accurate. Although very functional, this system is not portable or flexible; the software would have to be substantially rewritten for other applications. (2) An application generator which has the capability of "building" a

specific alarm processing and display application in a matter of a few hours, using the site definition developed in the security planning phase to produce the custom application. This package is based on a standardized choice of hardware, within which it is capable of building a system to order, automatically constructing graphics, data tables, alarm prioritization rules, and interfaces to peripherals. (3) A software tool, the User Interface Management System (UIMS), is described which permits rapid prototyping of human-machine interfaces for a variety of applications including emergency management, alarm display and process information display. The object-oriented software of the UIMS achieves rapid prototyping of a new interface by standardizing to a class library of software objects instead of hardware objects.

37687 **(SAND—86-0702C) SENLEX: a sensor layout expert system.** Ward, J.D.; Sena, K.J. (Sandia National Labs., Albuquerque, NM (USA)). 25 Jun 1986. Contract AC04-76DP00789. 5p. (CONF-860654—18). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012172.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

An expert system is under development to carry out intrusion detection sensor placement for physical security systems. Expert systems are computer programs that use symbolic programming techniques to duplicate the reasoning processes of human experts. Because sensitive facilities often require complex, multisensor intrusion detection systems, the design rules for achieving high levels of detection performance are not easily transferred to novices. Since these design rules reside in the minds of the individual experts performing the tasks, the need to consolidate this knowledge in a form that is available to others was a driving force in this project. The first phase of this project is described in this paper. It consists of an expert system for sensor placement in a graded clear zone. The program has the capability of handling several different sensor types and of coordinating the placement of multiple sensor types. The designs produced by the program in comparison with the designs produced by human experts are discussed.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

37688 **(UCRL—93698) Statistical theory of electronic energy relaxation.** Anderson, J.B.; Foch, J.D.; Shaw, M.J.; Stern, R.C.; Wu, B.J. (Lawrence Livermore National Lab., CA (USA); Pennsylvania State Univ., University Park (USA). Dept. of Chemistry). 1986. Contract W-7405-ENG-48. 10p. (CONF-860636—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011888.

From 15. international symposium on rarefied gas dynamics; Grado, Italy (16 Jun 1986).

A 'statistical method' is developed for treating electronic and electronic-translational energy transfer in systems of atoms having multiple electronic states. This method is based on the assumption that the states produced in a collision are distributed according to the equilibrium distribution for the energy available to the collision partners. The approach is readily incorporated into Monte Carlo gas dynamic calculations. Results of such calculations are reported for several cases of relaxation of electronic energy in a static gas and in a cylindrical source flow.

37689 **Lawrence Livermore National Laboratory's Atomic Vapor Laser Isotope Separation program: laser technology and demonstration facilities.** Moses, E.I. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 182 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The Atomic Vapor Laser Isotope Separation (AVLIS) program at Lawrence Livermore National Laboratory (LLNL) is developing a large-scale process for photophysically enriching isotopes of several elements. The program now deploys plant prototypical hardware to demonstrate this enrichment process at full scale. The Laser Demonstration Facility, a fully integrated laser system has been constructed and when complete will produce more than 5000 W of tunable average power at a pulse repetition frequency >10 kHz. In AVLIS, an atomic vapor of mixed isotopes is irradiated with laser light precisely tuned to photoionize only desired isotopes. The resulting electrically charged photoions are deflected in an electric field to collector (or extractor) plates where they condense as enriched products. The AVLIS laser system consists of a series of high-average-power dye lasers optically pumped by an array of copper lasers. The dye lasers are used to do the three-step photoionization process. These lasers are well suited for the AVLIS process for both technical and economic reasons. They provide the precise narrowband (<100-MHz), short-pulse (<100-nsec), high-average-power, high-repetition-frequency laser light required by the atomic spectroscopy and vapor flow properties. Equally important, the capital and operating costs of this laser system in its present state of development are consistent with a commercially viable process deployment.

37690 **IR photosysis of SeF_6: isotope separation and dissociation enhancement using NH_3 and CO_2 lasers.** Tiee, J.J.; Wittig, C. (Univ. of Southern California, Los Angeles). *Journal of Chemical Physics;* **69**: No. 11, 4756-4761(1 Dec 1978).

The isotopically selective ir photodissociation of SeF_6 using two lasers is reported. The output from an NH_3 laser (780.5 cm^{-1}, 0.75 J, 0.5 μsec FWHM) and a line tunable CO_2, TEA laser (2.5 J, 150 nsec FWHM) are combined in order to enhance the photodissociation rate. Although the CO_2 laser output by itself is ineffective in dissociating SeF_6, the CO_2 laser output can enhance the NH_3 laser photolysis of SeF_6 by as much as a factor of 50. The authors find that the isotopic selectivity is independent of the CO_2, laser energy, and the rate of dissociation is unaffected by changing the CO_2 laser frequency. 14 references, 5 figures, 2 tables.

0703 Isotopic Power Supplies

37691 **Carbon-bonded carbon fiber insulation for radioisotope space power systems.** Wei, G.C.; Robbins, J.M. (Oak Ridge National Lab., TN). *American Ceramic Society Bulletin;* **64**: No. 5, 691-699(May 1985). Contract AC05-84OR21400.

A carbon-bonded carbon fiber (CBCF) insulation developed for a radioisotope heat source is made from chopped rayon fiber about 10 μm in diameter and 250 μm long, which is carbonized and bonded with phenolic resin particles. The CBCF is an excellent lightweight insulating material with a nominal density of 0.2 Mg/m^3 and a thermal conductivity of 0.24 W/(m-K) in vacuum at 2000°C. Several attributes that make CBCF particularly suitable for the heat source application have been identified. These include light weight, low thermal conductivity, chemical compatibility, and high-temperature capabilities. The mechanical strength of CBCF insulation is satisfactory for the application. The basic fabrication technique was refined to eliminate undesirable large pores and cracks often present in materials fabricated by earlier techniques. Also, processing was scaled up to increase the fabrication rate by a factor of 10. The specific properties of the CBCF were tailored by adjusting material and processing variables to obtain the desired results. 22 references, 13 figures, 4 tables.

08 HYDROGEN

0801 Production

REFER ALSO TO CITATION(S) 37491

37692 **(ESA-SP—40, pp vp) Critical view of photochemical and photoelectrochemical methods for hydrogen production.** Getoff, N. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Methods for hydrogen production by water splitting using solar energy are reviewed. Water photolysis and solar radiation; homogeneous and heterogeneous photoredox sysems; photogalvanic cells; liquid-junction transducers; and hybrid water splitting systems are discussed. Results concerning the reaction mechanisms of decomposition reactions are presented. The most promising systems for hydrogen production by solar energy seem to be liquid-junction transducers and hybrid systems.

37693 (ESA-SP—40, pp vp) **Role of hydrogen in solar energy utilization: problems and aspects of the hydrogen issue.** Gretz, J. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

The thermodynamics of water splitting is reviewed. A hydrogen-based, clean energy supply concept comprising the production of hydrogen by hydropower, its transportation to Europe, and its storage and use in different forms is described. The economic aspects are treated.

37694 (ESA-SP—40, pp vp) **Solar energy: one decade of research and application, review and outlook.** Faninger, G. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

The state of the art of solar technologies and the problems opposing their large-scale market introduction are described. Hydrogen production, heat generation, and electricity production are considered.

37695 (EUR—10290-EN) **Prospects for hydrogen from advanced water electrolysis - based on results emanating from the EEC R and D subprogramme on hydrogen (1975-1983). Final report.** Glynn, P. (Commission of the European Communities, Luxembourg. Directorate General Information Market and Innovation). 1986. 151p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

The purpose of this study was to investigate the commercial prospects of producing hydrogen by the process of advanced electrolysis. This new technology has been researched within the framework of the First and Second Energy R and D Programmes of the European Community and has been proven on a laboratory scale. With 69 tabs., 4 figs.

0804 Marketing And Economics

REFER ALSO TO CITATION(S) 37693

09 OTHER SYNTHETIC AND NATURAL FUELS

0901 Hydrocarbon Fuels

REFER ALSO TO CITATION(S) 37304

37696 (AD-A—165676/8/XAB) **Low-temperature methanation and Fischer-Tropsch activity over supported ruthenium, nickel, and cobalt catalysts.** Powell, J.B.; Langer, S.H. (Wisconsin Univ., Madison (USA). Dept. of Chemical Engineering). 1985. 5p. NTIS, PC A02/MF A01.

It has been shown previously that surface carbon derived from the dissociation of CO on supported ruthenium, nickel, and cobalt catalysts at temperatures in excess of 423 K can be hydrogenated to methane at room temperature. However, methanation activity for CO absorbed at ambient temperatures on these catalysts has not been observed. Reported here is methane formation from CO adsorbed under H_2 and hydrogenated at ambient temperature (298-307 K) on supported ruthenium, nickel, and cobalt catalysts. Hydrocarbon chain growth on ruthenium at a slightly higher temperature (324 K) is also reported. A sensitive stopped-flow gas-chromatographic reactor technique was employed to measure the small rates of reaction at these temperatures.

37697 (IVEM—5) **Environmental and energetical consequences of biogas production from manures.** Okken, P.A. (Rijksuniversiteit Groningen (Netherlands)). Aug 1985. 243p. (In Dutch). Interfakultaire Vakgroep Energie- en Milieukunde RU, P.O. Box 72, 9700 AB Groningen, Netherlands.

Production of biogas by anaerobic digestion of manure is a valuable source of energy for farms, and it is a way to get rid of excess of manure. Biogas production may happen at the farm for captive use or more centralized from manure collected from nearby farms. In the first case no stringent quality requirements are needed, however, pollution and corrosion problems may arise. In the second case more sophisticated and bigger plants are possible. Energy output and gas quality are better, but transport of manure is a weak point. The use of lorries affect the net energy output and spill of manure is an inevitable daily source of nasty smell. Underground pipeline transport could be a solution. Since mineral quantities do not change during digestion, biogas production is no solution for phosphate and nitrate burden of the environment. 278 refs.

37698 (NLH/IBT/R—195) **Pilot plant for extraction of biogas. Technical description.** Tjernshaugen, O.; Soerreime, J.; Gjervan, J.O.; Hansen, I.F. (Norges Landbrukshoegskole, Aas. Inst. for Bygningsteknikk). Sep 1983. 19p. (In Norwegian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752494.

The report discribes a research biogas plant built in 1979-1980 in Rogaland (Norway). The plant was built closely connected to a dairy barn. The reactor is made of concrete, and is divided into 2 equal parts by means of a vertical wall. Each part contain 45 m^3 of manure, and has a storage capacity of 15 m^3 for gas storage. The agitation in the reactors is carried out by means of submerged pumps. To warn up the anaerobic process, it it used heat exchangers placed inside the reactors. A generator is used to convert the gas into electrical power. 6 drawings.

37699 (NP—6752497) **Production of biogas (methane) and utilization as an alternate energy source.** Prasad Yapa Kalatunga, D.V. (Norges Landbrukshoegskole, Aas. Mikrobiologisk Inst.). 1982. 81p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86752497.

Anaerobic digestion method provides not only economical recovery of some of the organic waste as methane as an alternate source of energy, but also provides sanitary treatment of organic wastes, satisfactory control of fly-breeding, and retention of the humus matter and nutrients for use as fertilizer. The report deals with the basic microbiology such as anaerobic metabolism and processes in an anaerobic digester together with theorectical aspects of methanogenesis such as taxonomy, physiology of methanogenic bacteria, environmental factors, and biochemistry of methane production. The report also discusses several types of digesters together with the utilization of bio gas, the utilization of digested materials, and also reduction of pathogens in the process. 19 drawings, 18 tables.

37700 (PB—86-188976/XAB) **Woodgas burners: background and design. Special report.** Hose, F.R. (National Timber Research Inst., Pretoria (South Africa)). Mar 1985. 37p. (CSIR/SR/HOUT—388). NTIS, PC A05/MF A01.

In the report, aspects of flame characteristics and general burner design are examined. Special interest is paid to the combustion of woodgas. The conclusion is reached that, under certain conditions, wood gas is an effective yet easy gas to use for heat generation.

37701 (PB—86-189644/XAB) **Main fans for wood-gas systems: evaluation and design. Special report.** Hose, F.R. (National Timber Research Inst., Pretoria (South Africa)). Mar 1985. 37p. (CSIR/SR/HOUT—385). NTIS, PC A05/MF A01.

The performance of a centrifugal fan, which had been successfully used as the main fan of a wood-gas system, was measured under a variety of test conditions. The aim of the tests was to derive a fan characteristic curve that allows the evaluation or pre-

diction of fan performance under different circumstances. In addition, information on impeller materials have been included.

37702 **(PB—86-192374/XAB) Practical test on a wood gasifier using whole-tree thorn-bush chips. Special report.** Hose, F.R. (National Timber Research Inst., Pretoria (South Africa)). Dec 1984. 54p. (CSIR/SR/HOUT—370). NTIS, PC A06/MF A01.

A new type of wood gasifier has recently been developed in South Africa. Its most important attribute is that it can accept a wide range of fuels including, for example, whole tree chips. This report describes a second practical test to which one of these gasifiers was submitted. The main purposes of the test was to evaluate under typical industrial user conditions: (1) the energy conversion performance of the gasifier and the complete wood-gas system; and (2) the economic viability of complete woodgas system.

37703 **(SERI/TP—232-2957) Comparative technical evaluation of acid hydrolysis processes for conversion of cellulose to alcohol.** Wright, J.D.; Power, A.J. (Solar Energy Research Inst., Golden, CO (USA)). May 1986. Contract AC02-83CH10093. 27p. (CONF-860405—5). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010696.

From 10. annual symposium on energy from biomass and wastes; Washington, DC, USA (7 Apr 1986).

This paper evaluates five major acid hydrolysis processes for the conversion of lignocellulosic feedstocks to ethanol. A complete conversion process was defined, and alternative hydrolysis processes integrated into this framework. The sensitivity of the process economics to technical improvements was also evaluated. In dilute acid hydrolysis processes, the acid hydrolyzes cellulose to glucose while simultaneouly degrading the product sugars. The progressing batch reactor uses several percolation reactors in series to quickly remove the sugars from the reaction zone, minimizing sugar degradation while minimizing product dilution. The high temperature plug flow reactor has low yields, but converts the xylan fraction of the wood to furfural, a valuable chemical intermediate. The concentrated acid processes break down the crystalline structure of the cellulose, rendering it amorphous and readily hydrolyzable at conditions where sugar degradation is minimal and yields approach 100%. The process suffers from the expenses associated with handling large quantities of acid. The concentrated sulfuric acid processes consume large quantities of acid, and suffers from high acid replacement costs. The HCL processes recover the acid by distillation, which requires large amounts of energy and extremely expensive corrosion-resistant equipment. The HF-based process has high acid consumption costs because HF is very expensive, and would suffer high capital and operating costs because of the extremely hazardous nature of the catalyst. 40 refs., 8 figs., 3 tabs.

37704 **(TNO-HMT—85-010120) The importance of anaerobic digestion of manure for energy, environmental and resource policy.** Mot, E.; Gerritse, G.; Van Voorneburg, F.; Rulkens, W.H. (Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands)). Dec 1985. 177p. (In Dutch). Hoofdgroep MT-TNO, P.O. Box 342, 7300 AH Apeldoorn, Netherlands, Dfl. 40.00.

Cost benefit analysis is given of anaerobic digestion of manure. Two approaches are dealt with: small scale production (100 cattle unit plants) and large scale production (20,000 cattle unit plants). Aspects concerning energy, resources and environment are quantified. Main profits of small scale digestion lie in biogas production and reduction of nasty smell. Profits are social profits; though expressed in money (Dfl.) they are not always financial profits. Analysis of the large scale digestion process shows that choosing digestion as first step has a positive effect on all following steps. Process heat can be used and less chemicals are needed. Large scale manure digestion of 20 million tonnes/year in 75 plants requires a total investment of Dfl. 1.4 billion and results in a profit of 67 million per year. 68 refs.

0902 Alcohol Fuels

37705 **(DOE/CE/40772—T2) Production of chemicals from food processing wastes using a novel fermenter separator. Technical progress report, January 1-March 31, 1986.** Dale, M.C.; Koo, Y.M.; Park, C.H.; Chen, C.; Lin, J.; Moyer, P.; Okos, M.R.; Wankat, P.C. (Purdue Univ., Lafayette, IN (USA)). Apr 1986. Contract FG02-85CE40772. 77p. NTIS, PC A05/MF A01. File Number DE86009761.

Fundamental engineering design and operational studies were performed on reactors and separators in the area of food processing waste fermentation. These studies evaluated the fermentation kinetics and nutritional requirement of immobilized cells, and examined different packing materials and energy efficient ethanol separation concentration and recovery methods, followed by the design and construction of a pilot plant reactor unit. These data will be used to develop process design models to aid in designing energy efficient and cost effective processes for conversion of food processing wastes into chemicals. 15 refs., 17 figs.

37706 **(NMRDI—2-74-4614) New Mexico ethanol blended fuel economic impact study. Final report.** Bos, P.B. (Polydyne, Inc. and Associates, San Mateo, CA (USA)). May 1986. 137p. NTIS, PC A07/MF A01 - NMERDI Univ. of Nex Mexico, Suite M 457 Washington SE, Albuquerque, NM 87108. File Number DE86901463.

A comprehensive study of the New Mexico ethanol fuel production and blending industry was conducted to prepare objective information regarding the impact of the tax deductions on the ethanol fuel industry, the New Mexico economy, and on State revenues. The study involved a survey of the ethanol industry business activities, with the cooperation of the industry leaders; detailed technical and economic characterization of a representative New Mexico ethanol production facility; estimates of technology diffusion and market penetration rates based on logistic curve techniques; and modeling of the New Mexico economy by input-output analysis procedures.

37707 **Methanol synthesis studies using in situ FTIR spectroscopy.** Edwards, J.F.; Schrader, G.L. (Dept. of Chemical Engineering and Ames Lab., USDOE Iowa State Univ., Ames, IA). *American Chemical Society, Division of Gas and Fuel Chemistry, Preprints;* **31**: No. 2, 252-255(Apr 1986). (CONF-860425—).

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

Future demand for methanol could expand multifold as coal assumes a greater proportion of energy needs. Although methanol is presently economically unattractive as a substitute for gasoline, the State of California has begun a program to operate 550 vehicles with methanol because it produces fewer pollutants than gasoline. More than 300 privately-owned vehicles, converted by Future Fuels of America, Inc., are running on methanol in the Sacramento, San Francisco, and Los Angeles areas. Even if gasoline remains the major automotive fuel into the next century, methanol production could increase significantly if technology such as Mobil Oil's M-Gasoline process is used to produce gasoline. This process uses a zeolite catalyst (ZSM-5) to convert methanol into a blend of paraffins, cycloparaffins, and aromatics with a research octane number of 93, i.e., an unleaded premium gasoline. New Zealand will use this technology to convert natural gas into approximately 12,500 bbl/d of gasoline. Utilities using coal gasification technology for power generation will probably also manufacture methanol. During off-peak hours, part of the syngas would be converted to methanol and stored; during peak hours, the methanol would be used as fuel in gas turbines to meet the high electrical demand. And finally, there is great potential for future development of methanol as a primary feedstock in the chemical industry, especially as supplies of ethylene and propylene decrease. An example is the manufacture of acetic acid, where methanol has replaced ethylene as the primary feedstock in new technologies by BASF and Monsanto.

0904 Solid Waste And Wood Fuels

REFER ALSO TO CITATION(S) 37346, 37357, 37374, 37379, 37836, 38077, 38806, 38807

37708 **(AD-A—166393/9/XAB) Refuse-derived fuels in US Air Force heating and power systems. Final report, June 1982-February 1985.** Joensen, A.W. (Iowa State Univ. of Science and Technology, Ames (USA)). Jan 1986. 195p. NTIS, PC A09/MF A01.

This investigation was conducted to document and review all data associated with densified refuse-derived fuel (dRDF)--its preparation and properties, storage and handling, boiler cofiring efficiency and environmental emissions, potential boiler metal wastage, and any other experiences associated with the use of this fuel. The results of this investigation provide the basis for the development of an optimum dRDF fuel specification. These results identify performance characteristics and operating problems of the existing dRDF fuel pellet and contain an economic feasibility assessment of using this fuel.

37709 **(EUR—9951-FR) Analysis of agronomical constraints in connection with the utilisation of straw as an energy source. Final report.** Chassin, P. (Institut National Agronomique, 75 - Paris (France)). 1985. 115p. (In French). Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energie.

The main objectives of the researches proposed by several French INRA (Institut National de la Recherche Agronomique) teams can be outlined in the following manner: Impact evaluations upon the soil properties of a radical modification in the organic stock management (due to the use of by products as energy feedstocks). Definition of an agronomically safe (limited) 'biomass deposit' for energy production and an optimum management of vegetable biomass in terms of both energetic and agricultural purposes. Study of the socio-economic consequences of the introduction of new energy paths within rural areas subject to intensive or extensive farming practices. Development of economic methods for analyzing and forecasting the costs of new energy paths.

37710 **(KVL-JI-MEDD—52) Charcoal and heat produced by straw and wood combustion. Possibilities, methods and economy.** Holm, M.; Have, H. (Kongelige Veterinaer- og Landbohoejskole, Tastrup (Denmark). Jordbrugsteknisk Inst.). Dec 1985. 117p. (In Danish). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752101.

A technical and economic investigation has been made to explore the possibilities of transforming surplus straw and waste wood into charcoal in special pyrolysis plants, which are functioning as heating plants for the biomass producer or in connection to a district heating network. Further it is investigated whether the produced charcoal is a suitable and economic energy carrier for supply of surplus biomass energy from rural to urban areas. Pyrolysis of straw at 400 deg C yields a charcoal which on a weight basis corresponds to about 33% of the dry matter content in the raw material, and in terms of energy content carries about 50% of the original energy content of the straw. Charcoal produced from straw, at the above temeprature, contains about 15 - 20% of ashes while charcoal from wood contains less than 2%. For both types of charcoal, the content of volatiles is 20 - 25% of the dry matter minus ashes. This content is high enough to make ignition easy but still low enough to avoid smoke from the combustion. The charcoal can perhaps be produced at a price of 80 - 90 Dkr./GJ at 2 MW pyrolysis heating plants, if the straw is paid with 420 Dkr/ton and labour costs are charged at normal rates. The calculated production prices are at the same level as light fuel oil but considerably higher than the prices of alternative solid fuels, as straw pellets and wood chips.

37711 **(PB—86-189651/XAB) Dryers for wood fuels: design and evaluation. Special report.** Hose, F.R. (National Timber Research Inst., Pretoria (South Africa)). Mar 1985. 36p. (CSIR/SR/HOUT—383). NTIS, PC A05/MF A01.

A procedure is given for the calculation of the quantity of drying air required and the amount of water removed from wood or biomass fuel during drying. The calculated results are compared with the values obtained in tests using fluidized bed and vibrating conveyor dryers.

37712 **(STEV-SB—86-5) Drying of wood fuel in oil and vacuum.** Bystedt, T. (Statens Energiverk, Stockholm (Sweden)). Dec 1985. 53p. (In Swedish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752483.

Under point 1 the course of events from idea up to the formation of the Hager System AB is outlined (summarized). Particularly the background material regarding the fuelwood project is discussed. The first stage, which was an investigation project, was supported by the National Swedish Board for Energy Source Development. The result of this stage indicated that the drying-process could be profitable and that there was a market for the process. Because of the economic situation of Kockums Industri the project was postponed. The drying experiment, which was done during stage 2, showed that the moisture content could be reduced very rapidly, however, some oil was absorbed by the wood. The discussion on the technical premises including oil absorption, storing of fuelwood, filtration of oil, separation of condensate and energy recovery indicates that there are possibilities to realize the drying process. However, the technical solution must be profitable for the process. Summing up, experience shows that it is possible to dry fuelwood, but an oil absorption will occur. This absorption will increase the energy value and improve the storage properties of the fuelwood. A continuation of the work will demand that a smaller lab plant is built. A suitable place for this lab plant is the Swedish University of Agricultural Sciences, Department of Forest Products, where there also are staff resources to carry through a research and development program for the project.

37713 **(STEV-SB—86-6) Topical report on the use of waste as fuel.** Sundqvist, S. (Statens Energiverk, Stockholm (Sweden); VIAK AB, Vaellingby (Sweden)). Jan 1986. 96p. (In Swedish). (VIAK—4913-04-4724). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752484.

The aim of this investigation has been to collect and report the facts concerning the use of domestic and industrial waste for the production of heat and electric power. The amount capacities, organisations and markets have been surveyed. The actual combustion of domestic waste amounts to 43% of the total and to 14% of combustible industrial waste. (G.B.).

37714 **(STEV-SB—86-9) Radar technique for the measurement of dry matter content in wood fuels. Stage I.** Blomqvist, H.; Bruch, H.; Nylinder, M. (Statens Energiverk, Stockholm (Sweden)). Mar 1986. 37p. (In Swedish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752486.

This study has been financed by the National Energy Board and carried out jointly by the Department of Forest Products and Skandinavisk Radarsondering AB. The report is dealing with the feasibilities of measuring, by radar technique, the dry matter content in wood fuel. The measurements have been done on loads of non-frozen and frozen sawdust. The equipment used in this operation is a SIR-system (Subsurface Interface Radar). The results show that it is possible with this equipment to establish the dry matter content in non-frozen sawdust with a high degree of accuracy. As regards altogether frozen material the degree of accuracy is quite as high. If, however, the material is partly frozen this method will present divergent dry matter values. How great these divergences would be in practical measurement depend upon the portion of frozen material, a matter which has not been studied in this work. Furthermore, it remains to be solved to what extent the results will be conveyable to other assortments, such as fuel chips, bark, and sawmill chips.

37715 **(STEV-TORV—86-4) Sampling for analysis of biofuels.** Olsson, R.; Bergner, H.; Burvall, J.; Granberg, R.; Johansson, E.; Persson, J.Aa.; Sandstroem, T.; Simonsson, U. (Statens Energiverk, Stockholm (Sweden)). 1985. 66p. (In Swedish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752275.

Sampling for determination of dry substance in biofuels is complicated and to obtain acceptable results every load should be sampled. To obtain an acceptable result for the dry substance value the following criteria should be fulfilled. A number of small samples should be united to a sample which thereafter is analysed. Each sample should be at least 5 litres of biofuel. A generally useful number for the dry substance, within load standard deviation is 3% for biofuels. This means that differences between parallel individual samples often is 5% and that 5-10% differences can arise without any (intentional) errors. Sampling for determination of ash content is simpler than sampling for analysis of dry substance and therefore the sampling frequency can be reduced to one tenth of the samples taken for the determination of dry substances. For small contractors, 30 loads or less, more samples should be taken in a preventive end to avoid meddling of unwanted materials. Sampling for determination of calorific value, sulphur, carbon hydrogen, and nitrogen is also easier than sampling for determination of dry substances. These values vary with the production place, peat pile, rather than within or between loads. Because of the inhomogenities in the loads there is no need for the method to have a higher precision than 1-2% as long as it is accurate. The theoretically optimal way is to measure on biofuel streams (e.g. IR or microwave measurements on moving belts) where 20-200 measurements can be made on each load. Correct sampling for small contractors will to day give a procentually higher cost due to the necessary high frequent sampling. This fact makes the salesprice lower which might curb low volume contracting of biofuels. A low frequent sampling will give an uncertain price, and thereby an uncertain income for the low volume producer.

37716 **(SVF—198) Corrosion of grate tubes in wood-fired hot-water boilers. Field tests at Vilhelmina Vaermeverk 1983-1984.** Norelius, E.; Bruno, F. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Aug 1985. 54p. (In Swedish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752150.

The boilers are constructed with a slanting tube grate, consisting of 60.5 x 4.0 mm carbon-steel tubes with intermediate stabilizing surface, equipped with combustion-air inlets. Some of these boilers are directly connected to the district heating system, which means that the inlet temperature of the boiler is the same as the return temperature of the district heating system. In a small part in the center of the combustion zone, the corrosion of the grate tubes is very high. Difficulties have occurred to keep the boiler running even over one firing-season. The corrosion resistivity of three different types of material has been studied: - SAF 2205, which is a ferrit-austenite stainless steel, - Sanicro 28, which is a high-nickeliferous alloy, - Sandvik 5R10/4L7, which is the same as in common compound tubes of stainless steel SS 2352. As comparison material 60.3 x 4.5 mm carbon-steel tubes have been mounted among the test tubes in a test panel. The test panel was mounted within a hot-water boiler 'V and Aa' in Vilhelmina in the most exposed part of the tube grate. Some parts of the combustion tubes of carbon steel were provided with a protection coating of Kanthal Al (Fe-Cr-Al), which was sprayed onto the surface. In May, 1984, the thickness of the exposed tubes was measured by means of an ultrasonic measuring device. The results showed a very small decrease in thickness, caused by corrosion on the three tubes tested. The test shows that carbon steel is a dubious choise for the most exposed part of the grate and that the compound tubes with the surface part of stainless steel are economically reasonable and from the corrosion point of view a satisfactory alternative. Also the Kanthal alloy coating offers an interesting alternative.

13 HYDRO ENERGY

1302 Site Geology And Meteorology

37717 **(NP—6752105) Radio echo sounding of the marginal zone of the Inland Ice in the Disko Bay region 1984.** Hoejmark Thomsen, H.; Skov Madsen, P. (Groenlands Geologiske Undersoegelse, Copenhagen (Denmark)). Jan 1985. 27p. (In Danish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752105.

In connection with hydropower investigations at Pakitsup akuliarusersuaq, Jakobshavn and Kugssup tasia/Tiningnilik, Christianshaab, West Greenland, radio echo sounding has been carried out to map the topography beneath the marginal zone of the Inland Ice. The radio echo sounding was carried out as a colaboration between the Geological Survey of Greenland (GGU) and Electromagnetics Institute (EMI), Technical University of Denmark. A 300 MHz radar mounted in a Twin Otter aircraft was used. Although about 2200 km of radar profiles were planned the operation was stopped after 800 km of flying because no bottom echoes were recorded. Detailed inspection of data and radar equipment showed a circuit failure in the radar equipment and that only echoes from sporadic small reflectors within the ice were recorded, and it is concluded that the sensitivity of the radar equipment was insufficient for the task.

1303 Plant Design And Operation

37718 **(TKK-S/ST—55) Balance optimal hydro power system expansion planning model.** Lautala, P.; Vaelisuo, H.; Autti, M. (Helsinki Univ. of Technology, Otaniemi (Finland). Control Engineering Lab.). Jul 1984. 34p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752121.

Expansion planning of hydropower system with hydraulically connected power plants is dealt with. The capacity to cover daily load variations through the year is emphasized. Production curves are presented for the evaluation of the value of weekly average production. Then two methods - optimal open loop control and state feedback control - are presented for the determination of the operation strategy of the system and it is shown how the results are used in determining optimal harnessing of the system. An interactive program package based on the based on the methods is developed and optimization results of a system with five reservoirs and ten plants are presented.

1306 Environmental Aspects

REFER ALSO TO CITATION(S) 38943, 38944

37719 **(DOE/BP/13499—1) Stock identification of Columbia River chinook salmon and steelhead trout. Annual progress report.** Shreck, C.B.; Li, H.W. (Oregon State Univ., Corvallis (USA). Oregon Cooperative Fisheries Research Unit). Oct 1985. Contract AI79-83BP13499. 67p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86011384.

Fish were collected from 60 stocks of chinook salmon and 62 stocks of steelhead trout. Electrophoretic analyses were completed on 43 stocks of chinook salmon and 41 stocks of steelhead trout and meristic counts were completed on 43 stocks of chinook and 41 stocks of steelhead. Statistical comparisons between year classes indicate that most enzyme systems are stable over time but some may be dynamic and should be used with caution. We also compared neighboring stocks of both spring chinook and steelhead trout. Analysis of the chinook data suggests that, as expected, the number of statistically significant differences in isozyme gene frequencies increases as the geographic distance between stocks increases. The results from comparisons between adjacent steelhead stocks were inconclusive. Cluster analyses using either isozyme gene frequencies or meristic characters both tended to group the chinook and steelhead stocks by geographic areas and by race and both methods resulted in generally similar grouping patterns. Heterozygosity values for each stock were computed using the isozyme gene frequencies. Heterozygosity values among the areas were very similar for the steelhead stocks.

37720 **(DOE/BP/16687—2) Effects of water levels on productivity of Canada geese in the northern Flathead Valley. Annual report, 1985.** Casey, D.; Wood, M. (Montana Dept. of Fish, Wildlife and Parks, Kalispell (USA)). Apr 1986. Contract AI79-84BP16687. 94p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86011728.

Operation of Hungry Horse Dam on the South Fork Flathead River causes sporadic water level fluctuations along the main stem Flathead River. Changes in chronology of seasonal water level fluctuations and substantial habitat losses have occurred as a

result of construction and operation of Kerr Dam, which regulates Flathead Lake. These fluctuations may impact goose populations through flooding and erosion of nesting and brood-rearing habitats, and increased susceptibility of nests and young to predation. The number, location, and success of goose nests were determined through pair surveys and nest searches. Our 1985 pair count data indicated that 95 to 143 nests may have been present. Hatching success for 1985 nests (55%) was low compared to long-term averages for the region. Predation was the predominant cause of ground nest failure (25 nests); we documented 2 nest failures due to flooding. The maximum gosling count in the study area for 1985 was 197. Six key brood-rearing areas were identified. Most (80%) sites were located in the herbaceous or pasture cover type and the riparian bench landform. Analysis of aerial photographs taken prior to construction of Kerr Dam documented the loss of 1859 acres of habitat along the north shore of Flathead Lake. Losses were attributed to inundation and to continuing erosion due to operation of Kerr Dam. Lake and river water level regimes were compared with the chronology of important periods in the nesting cycle. Low lake levels in May and early June coincide with the breed-rearing period. Mudflats are heavily used by broods, but their effect on survival must still be documented. Preliminary recommendations to protect and enhance Canada goose habitat and production are being developed.

37721 **(DOE/BP/18969—1) Wildlife and wildlife habitat loss assessment at Hills Creek Dam and Reservoir Project, Middle Fork Willamette, River, Oregon. Final report.** Noyes, J.H.; Potter, M.S.; Bedrossian, K.L. (Oregon Dept. of Fish and Wildlife, Portland (USA). Environmental Management Section). May 1986. Contract AI79-84BP18969. 89p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86011722.

A habitat based assessment was conducted of the US Army Corps of Engineers' Hills Creek Dam and Reservoir Project on the Middle Fork Willamette River, Oregon, to determine losses or gains resulting from the development and operation of the hydroelectric related components of the project. Preconstruction, postconstruction, and recent vegetation cover types of the project site were mapped based on aerial photographs from 1944, 1964, and 1979, respectively. Vegetation cover types were identified within the affected area and acreages of each type at each period were determined. Fifteen wildlife target species were selected to represent a cross-section of species groups affected by the project. An interagency team evaluated the suitability of the habitat to support the target species at each time period. An evaluation procedure which accounted for both the quantity and quality of habitat was used to aid in assessing impacts resulting from the project. The Hills Creek Project extensively altered or affected 4662 acres of land and river in the Middle Fork Willamette River drainage. Impacts to wildlife centered around the loss of 2694 acres of old-growth forest and 207 acres of riparian habitat. Impacts resulting from the Hills Creek Project included the loss of winter range for Roosevelt elk, and the loss of year-round habitat for black-tailed deer, black bear, cougar, river otter, beaver, ruffed grouse, spotted owl, and other nongame species. Bald eagle and osprey were benefited by an increase in foraging habitat. The potential of the affected area to support wildlife was greatly altered as a result of the Hills Creek Project. Losses or gains in the potential of the habitat to support wildlife will exist over the life of the project.

37722 **(DOE/BP/18969—2) Wildlife and wildlife habitat loss assessment at Green Peter-Foster Project, Middle Fork Santiam River, Oregon. Final report, 1985.** Noyes, J.H.; Potter, M.S.; Bedrossian, K.L. (Oregon Dept. of Fish and Wildlife, Portland (USA). Environmental Management Section). May 1986. Contract AI79-84BP18969. 100p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86011674.

A habitat based assessment was conducted of the US Army Corps of Engineers' Green Peter-Foster Dam and Reservoir Project on the Middle Fork Santiam River, Oregon, to determine losses or gains resulting from the development and operation of the hydroelectric related components of the project. Preconstruction, postconstruction, and recent vegetation cover types at the project site were mapped based on aerial photographs from 1955, 1972, and 1979, respectively. Vegetation cover types were identified within the affected area and acreages of each type at each period were determined. Eleven wildlife target species were selected to represent a cross-section of species groups affected by the project. An interagency team evaluated the suitability of the habitat to support the target species at each time period. An evaluation procedure which accounted for both the quantity and quality of habitat was used to aid in assessing impacts resulting from the project. The Green Peter-Foster Project extensively altered or affected 7873 acres of land and river in the Santiam River drainage. Impacts to wildlife centered around the loss of 1429 acres of grass-forb vegetation, 768 acres of shrubland, and 717 acres of open conifer forest cover types. Impacts resulting from the Green Peter-Foster Project included the loss of critical winter range for black-tailed deer and Roosevelt elk, and the loss of year-round habitat for deer, upland game birds, river otter, beaver, pileated woodpecker, and many other wildlife species. Bald eagle and osprey were benefited by an increase in foraging habitat. The potential of the affected area to support wildlife was greatly altered as a result of the Green Peter-Foster Project. Losses or gains in the potential of the habitat to support wildlife will exist over the life of the project.

37723 **(DOE/BP/18969—3) Wildlife and wildlife habitat loss assessment at Dexter Dam and Reservoir Project, Middle Fork Willamette River, Oregon. Final report.** Noyes, J.H.; Potter, M.S.; Bedrossian, K.L. (Oregon Dept. of Fish and Wildlife, Portland (USA). Environmental Management Section). Sep 1985. Contract AI79-84BP18969. 79p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86011725.

A habitat based assessment was conducted of the US Army Corps of Engineers' Dexter Dam and Reservoir Project on the Middle Fork Willamette River, Oregon, to determine losses or gains resulting from the development and operation of the project. Preconstruction, post-construction, and recent vegetation cover types of the project site were mapped based on aerial photographs from 1944, 1956, and 1979, respectively. Vegetation cover types were identified within the affected area and acreages of each type at each period were determined. Fifteen wildlife target species were selected to represent a cross-section of species groups affected by the project. An interagency team evaluated the suitability of the habitat to support the target species at each time period. An evaluation procedure which accounted for both the quantity and quality of habitat was used to aid in assessing impacts resulting from the project. The Dexter Project extensively altered or affected 4662 acres of land and river in the Middle Fork Willamette River drainage. Impacts to wildlife centered around the loss of 445 acres of riparian habitat. Impacts resulting from the Dexter Project included the loss of year-round habitat for black-tailed deer, red fox, mink, beaver, western gray squirrel, ruffed grouse, ring-necked pheasant, California quail, wood duck and nongame species. Bald eagle, osprey, and greater scaup were benefitted by an increase in foraging habitat. The potential of the affected area to support wildlife was greatly altered as a result of the Dexter Project. Losses or gains in the potential of the habitat to support wildlife will exist over the life of the project.

37724 **(DOE/BP/18969—4) Wildlife and wildlife habitat loss assessment at Detroit Big Cliff Dam and Reservoir Project, North Santiam River, Oregon. Final report.** Noyes, J.H.; Potter, M.S.; Bedrossian, K.L. (Oregon Dept. of Fish and Wildlife, Portland (USA). Environmental Management Section). May 1986. Contract AI79-84BP18969. 90p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86011711.

A habitat based assessment was conducted of the US Army Corps of Engineers' Detroit/Big Cliff Dam and Reservoir Project (Detroit Project) on the North Santiam River, Oregon, to determine losses or gains resulting from the development and operation of the hydroelectric-related components of the project. Preconstruction, postconstruction, and recent vegetation cover types at the project site were mapped based on aerial photographs from 1939, 1956, and 1979, respectively. Vegetation cover types were identified within the affected area and acreages of each type at each time period were determined. Ten wildlife target species were selected to represent a cross-section of species groups affected by the project. An interagency team evaluated the suitability of the habitat to support the target species at each time period. An evaluation procedure which accounted for both the quantity and quality of habitat was used to aid in assessing impacts resulting from the project. The Detroit Project extensively altered or affected 6324

acres of land and river in the North Santiam River drainage. Impacts to wildlife centered around the loss of 1,608 acres of conifer forest and 620 acres of riparian habitat. Impacts resulting from the Detroit Project included the loss of winter range for black-tailed deer and Roosevelt elk, and the loss of year-round habitat for deer, river otter, beaver, ruffed grouse, pileated woodpecker, spotted owl, and many other wildlife species. Bald eagle and osprey were benefited by an increase in foraging habitat. The potential of the affected area to support wildlife was greatly altered as a result of the Detroit Project. Losses or gains in the potential of the habitat to support wildlife will exist over the life of the project.

37725 **(DOE/BP/18969—5) Wildlife and wildlife habitat loss assessment at Cougar Dam and Reservoir Project, South Fork McKenzie River, Oregon. Final report.** Noyes, J.H.; Potter, M.S.; Bedrossian, K.L. (Oregon Dept. of Fish and Wildlife, Portland (USA). Environmental Management Section). May 1986. Contract AI79-84BP18969. 87p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86011707.

A habitat based assessment was conducted of the US Army Corps of Engineers' Cougar Dam and Reservoir Project on the South Fork McKenzie River, Oregon, to determine losses or gains resulting from the development and operation of the hydroelectric related components of the project. Preconstruction, postconstruction, and recent vegetation cover types of the project site were mapped based on aerial photographs from 1953, 1965, and 1979, respectively. Vegetation cover types were identified within the affected area and acreages of each type at each period were determined. Fifteen wildlife target species were selected to represent a crosssection of species groups affected by the project. An interagency team evaluated the suitability of the habitat to support the target species at each time period. An evaluation procedure which accounted for both the quantity and quality of habitat was used to aid in assessing impacts resulting from the project. The Cougar Project extensively altered or affected 3096 acres of land and river in the McKenzie River drainage. Impacts to wildlife centered around the loss of 1587 acres of old-growth conifer forest and 195 acres of riparian hardwoods. Impacts resulting from the Cougar Project included the loss of winter range for Roosevelt elk, and the loss of year-round habitat for black-tailed deer, black bear, cougar, river otter, beaver, spotted owl, and other nongame species. Bald eagle and osprey were benefited by an increase in foraging habitat. The potential of the effected area to support wildlife was greatly altered as a result of the Cougar Project. Loses or grains in the potential of the habitat to support wildlife will exist over the life of the project.

37726 **(DOE/BP/18969—7) Wildlife and wildlife habitat loss assessment at Lookout Point Dam and Reservoir Project, Middle Fork Willamette River, Oregon. Final report.** Bedrossian, K.L.; Noyes, J.H.; Potter, M.S. (Oregon Dept. of Fish and Wildlife, Portland (USA). Environmental Management Section). May 1986. Contract AI79-84BP18969. 89p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86011731.

A habitat based assessment was conducted of the US Army Corps of Engineers' Lookout Point Dam and Reservoir Project on the Middle Fork Willamette River, Oregon, to determine losses or gains resulting from development and operation of the hydroelectric related components of the project. Preconstruction, postconstruction, and recent vegetation cover types of the project site were mapped based on aerial photographs from 1944, 1956, and 1979, respectively. Vegetation cover types were identified within the affected area and acreages of each type at each period were determined. Seventeen wildlife target species were selected to represent a crosssection of species groups affected by the project. An interagency team evaluated the suitability of the habitat to support the target species at each time period. An evaluation procedure which accounted for both the quantity and quality of habitat was used to aid in assessing impacts resulting from the project. The Lookout Point Project extensively altered or affected 6790 acres of land and river in the Middle Fork Willamette River drainage. Impacts to wildlife centered around the loss of 724 acres of old-growth conifer forest and 118 acres of riparian habitat. Impacts resulting from the Lookout Point Project included the loss of winter range for Roosevelt elk, and the loss of year-round habitat for black-tailed deer, western gray squirrel, red fox, mink, beaver, ruffed grouse, ring-necked pheasant, California quail, spotted owl, and other nongame species. Bald eagle and osprey were benefitted by an increase in foraging habitat. The potential of the affected area to support wildlife was greatly altered as a result of the Lookout Point Project. Loses or gains in the potential of the habitat to support wildlife will exist over the life of the project.

37727 **(DOE/NBM—6011688) Finding of no significant impact. Proposed fish passage improvements at Three Mile Falls Diverson Dam, Umatilla River, Oregon.** (Bureau of Reclamation, Boise, ID (USA). Pacific Northwest Region). May 1986. 121p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86011688.

The proposed action would improve both upstream and downstream passage by providing a new right bank ladder on Three Mile Falls Diversion Dam, modifying the existing left bank ladder, and installing rotary drum fish screens and related structures on the adjacent West Extension Irrigation District (WEID) Canal. Four other alternatives are considered in the environmental assessment (EA): a concrete apron plus a left bank ladder; a cap on the crest of the dam plus a left bank ladder; dam removal; and no action. The proposed fish passage improvements would have effects on the anadromous and resident fish populations which, viewed in the context of the Umatilla River basin, would be beneficial. Resident fish would receive incidental benefits from reduced mortalities at the diversion structures. However, given the regional context, as specified in the Northwest Power Planning Council's Fish and Wildlife Program, in which the proposed passage improvements would be implemented and the large increase in anadromous fish production necessary to restore historical population levels, the proposed actions are not considered to have significant environmental impacts.

14 SOLAR ENERGY

37728 **(ESA-SP—40) Solar energy 85: resources, technologies, economics.** Burke, W.R. (European Space Agency, 75 - Paris (France)). Nov 1985. 229p. NTIS, PC A11/MF A01.

The physics and potential of solar energy; solar energy and insulation; collection and storage of solar energy; process heat and chemicals; photochemistry and hydrogen; solar power plants and photovoltaics; technology assessment and space applications; and the place of solar energy in energy policies were discussed.

1401 Resources And Availability

37729 **(PNL-SA—13565) Empirical corrections to a rotating shadowband silicon cell pyranometer.** Michalsky, J.; Harrison, L.; LeBaron, B. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 4p. (CONF-860655—11). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012149.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

Empirical corrections to a silicon cell pyranometer are derived. The corrections cause the silicon cell pyranometer to closely mimic the output of thermopile instruments. Daily integrated total horizontal, diffuse horizontal, and direct normal irradiances are within 1%, 3%, and 2.5% of thermopile values on the average. Ten-minute integrated values of these same silicon cell components seldom differ by more than 20 watts/m^2 from their thermopile counterparts.

37730 **(PNL-SA—13968) Spectral distribution and variation of solar radiation.** Michalsky, J.J. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 8p. (CONF-860655—13). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012148.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

Measurements of the solar resource have long been made with pyranometers and pyrheliometers. Few, however, have attempted to measure the resource with any appreciable spectral resolution. In this paper several of the solar technologies that could

use a spectral data base are described. This is followed by an explanation of how the atmosphere affects the transport of extraterrestrial solar radiation. Present attempts to model these atmospheric effects and current measurement plans for obtaining minimal data base of low spectral resolution data are presented. Finally, suggestions for improving the current state of spectral resource assessment are offered.

37731 **Natural convection in solar systems.** Kreith, F.; Anderson, R. (Solar Energy Research Institute, Golden, CO). pp 881-939 of Natural convection: Fundamentals and applications. Kakas, S.; Aung, W.; Viskanta, R. New York, NY; Hemisphere Publishing (1985).

The source of the sun's energy is a hydrogen-to-helium thermonuclear reaction. The outer layer of the sun, from which the solar radiation emanates, has an equivalent black body temperature of about 5760°K (5487°C). Approximately 30% of the solar energy inpinging on the outer fringes of the atmosphere is reflected back into space. The reamining 70%, approximately 120,000 terawatts, are absorbed by the earth and its atmosphere. Solar radiation reaching the earth consists of direct radiation that casts a shadow and be concentrated and diffuse radiation that has been scattered along its path from sun to earth. In accordance with the diameter of the sun and the distance between the sun and the earth, the direct component of radiation arrives on earth within a cone of about 0.5°. However, upon entering the earth's atmosphere some of the direct solar radiation is scattered by air molecules, aerosols and clouds. This radiation arrives on earth from all directions over the sky and is referred to as diffuse solar radiation. In passing through the atmosphere, radiation is not only scattered, but some of it is absorbed. In a turbid atmosphere, especially if it contains large aerosols, forward scattering occurs and the radiation cone is broadened. The direct radiation within this broadened cone is often referred to as circumsolar radiation and is usually centered within a cone of 5° about the center of the sun. Circumsolar radiation is available to a focusing collector only if it falls within the acceptance angle, but is not available to highly concentrating collectors such as central receivers.

1403 Economics

REFER ALSO TO CITATION(S) 37768, 37772, 37773

37732 (ESA-SP—40, pp vp) **Other aspect of solar energy utilization. Solar technologies export enhancement: a central European point of view.** Winter, C.J.; Nitsch, J.; Klaiss, H.; Voigt, C. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

It is shown that solar energy utilization can, on a moderate scale, supplement the indigenous energy supply of the Federal Republic of Germany. It can contribute to the prevention of fatal ecological damage, open an attractive export market and, in the long run, prepare ground for North-South compensation, where energy-poor but technology rich countries cooperate with countries of the Third World, which are often rich in raw materials and are situated in the solar belt of the world, for the benefit of the implementation of a solar industry or the production of a marketable synthetic solar energy carrier.

1405 Solar Energy Conversion

REFER ALSO TO CITATION(S) 37359, 37692, 37698, 37699, 37709, 37712, 37714, 37715, 38446

37733 (DOE/JPL/956289—86/1) **High efficiency crystalline silicon solar cells. Third technical report; final technical report.** Sah, C.T. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Jun 1986. Contract NAS-7-100-956289. 87p. NTIS, PC A05/MF A01; GPO Dep. File Number DE86012585.

A review of the entire research program since its inception ten years ago is given in this final report. The initial effort focused on the effects of impurities on the efficiency of silicon solar cells to provide figures of maximum allowable impurity density for efficiencies up to about 16 to 17% (AM1). Highly accurate experimental techniques (Capacitance Transient Spectroscopy) were extended to characterize the recombination properties of the residual impurities in silicon solar cell. A novel numerical simulator of solar cell was also developed, using the Circuit Technique for Semiconductor Analysis, which has provided exact theoretical design criteria on the maximum allowable impurity density. Recent effort until the end of the program has focused on the delineation of the material and device parameters which limited the silicon AM1 efficiency to below 20% and on an investigation of cell designs to break the 20% barrier. It is shown that the known and newly proposed high efficiency design criteria, if all implemented successful in one cell, could give AM1 efficiencies of 20% or higher. These include implementing a thin graded-base back-surface-field by epitaxy, minimizing emitter contact and surface or interface recombination losses using high/low emitter junctions, removing junction perimeter recombination losses, and maintaining a high base lifetime. It is concluded that the practical limitation in silicon cells with efficiency substantially higher than 20% comes from recombination of the photogenerated carriers at the residual impurity and defect recombination centers in the base. This calls for further research on the fundamental characterization of the carrier recombination properties at the chemical impurity and physical defect centers. It is further shown that only single crystalline silicon cell technology can be successful in attaining efficiencies greater than 20%.

37734 (DOE/JPL/956312—14) **Stress and efficiency studies in EFG. Quarterly progress report, October 1-December 31, 1985.** (Mobil Solar Energy Corp., Waltham, MA (USA)). 15 Jun 1986. Contract NAS-7-100-956312. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012138.

Modeling of the effect of transverse isotherm variation on residual stress has established that significant reductions in stress can be produced when the sheet edge is cooled with respect to the center. The potential to achieve large stress reductions exists but the quantitative details of the stress reductions depend on the creep relaxation. This is not known accurately in the region between 800°C and 1200°C where the residual stress is very sensitive to the transverse isotherm curvature. An apparatus for measurement of stress relaxation in silicon at these temperatures has been built and tested and will be used to examine creep behavior in more detail under a continuation contract. EBIC characterization of dislocated FZ silicon stressed at high temperatures has established correlations between the bulk minority carrier diffusion length and the dislocation density. Other results suggest that stress applied during annealing will influence diffusion length degradation arising from thermal effects. Studies of dislocation electrical activity as a function of dopant concentration indicate that increased dopant concentrations lead to a wider region of low current collection around the dislocation.

37735 (ESA-SP—40, pp vp) **Solar radiative energy.** Sizmann, R. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Solar radiation conversion into heat, electrical, and chemical energy is discussed. The theoretical limits of energy conservation along these conversion paths are considered. Thermal conversion is improved by use of optically selective absorbers. There are fundamental analogies betweenphotovoltaics, photochemical and (optically selective) photothermal processes. Natural photosynthesis is taken as an example for a balance of energy yield from solar irradiance.

37736 (ESA-SP—40, pp vp) **Technology assessment of solar energy utilization.** Jaeger, F. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

The general objectives and methods of technology assessment (TA) are outlined. Typical analysis steps of a TA for solar energy are reviewed: description of the technology and its further development; identification of impact areas; analysis of boundary conditions and definition of scenarios; market penetration of solar technologies; projection of consequences in areas of impact; and assessment of impacts and identification of options for action.

37737 (ESA-SP—40, pp vp) **Space applications of solar energy systems.** Bogus, K.; Kassing, D. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Space solar energy systems are reviewed. The European technology development program is discussed. Interactions with non-European space programs, and interactions with the development of terrestrial photovoltaics are considered.

37738 (GA-A—18285-Add.) **High-pressure catalytic metal reactor in a simulated solar central receiver. Addendum.** (GA Technologies, Inc., San Diego, CA (USA)). May 1986. Contract AC03-83SF11929. 5p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011870.

An addendum to the original report is presented in the form of a foreword. (BCS)

37739 (SERI/STR—211-2931) **Optimization of p-$CuInSe_2$n-CdZnS solar cells. Final subcontract report, 15 April 1984-30 September 1985.** Birkmire, R.W. (Delaware Univ., Newark (USA). Inst. of Energy Conversion). May 1986. Contract AC02-83CH10093. 19p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010700.

This research was conducted to fabricate $CuInSe_2$/CdS solar cells on well-characterized $CuInSe_2$ single-crystal wafers in order to improve our understanding of thin-film polycrystalline devices. $CuInSe_2$ wafers were supplied to the Institute of Energy by K. Bachmann of North Carolina State University. CdS was deposited onto the wafers to make $CuInSe_2$/CdS heterojunctions. Some wafers were treated in a Se atmosphere to lower the resistivity and to homogenize properties through the wafer. Not all wafers were single-crystal. The wafers were characterized in terms of resistivity, carrier type, composition and crystallographic structure. The $CuInSe_2$/CdS cells had efficiencies over 4% and open-circuit voltages over 0.45 V. The number of wafers and their quality limited the device performance achievable in this work.

37740 (SERI/STR—211-2932) **AlGaAs-GaAs patterned Ge tunnel junction cascade concentrator solar cell. Annual subcontract report, 15 October 1984-14 October 1985.** (Research Triangle Inst., Research Triangle Park, NC (USA)). May 1986. Contract AC02-83CH10093. 71p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010699.

The long-term goal of this research was to demonstrate a two-junction cascade solar cell (0.5 cm^2) composed of AlGaAs-GaAs having an AM2 conversion efficiency of more than 30%. As part of this work, Si has been selected as the best n-type dopant to date, and Mg, the best p-type dopant. B-doped, p^+-Ge epilayers have been grown with mirror-like surface morphologies and hole concentrations above 10^{20} cm^{-3}. Intercell ohmic connections have been fabricated using n^+-GaAs/p^+-Ge/p^+-GaAs sandwiched structures. GaAs bottom cells having mirror-like surface morphologies have been grown with efficiencies of 8 to 12%. Al/sub x/Ga/sub 1-x/As top cells have also been obtained, but no satisfactory photovoltaic action has yet been measured. A complete Al/sub x/Ga/sub 1-x/As/GaAs cascade cell using the patterned n^+-GaAs/p^+-Ge/p^+-GaAs sandwiched 10C has also been fabricated.

37741 (SERI/TP—211-2960) **Status and future of government-supported amorphous silicon research in the United States.** Wallace, W.L.; Sabisky, E.S. (Solar Energy Research Inst., Golden, CO (USA)). Jun 1986. Contract AC02-83CH10093. 6p. (CONF-860874—2). NTIS, PC A02/MF A01. File Number DE86010702.

From 2. international photovoltaic science and engineering conference; Beijing, China (1 Aug 1986).

The Amorphous Silicon Research Project (ASRP) was established at the Solar Energy Research Institute in 1983 and is responsible for all US Department of Energy government supported research activities in the field of amorphous silicon photovoltaics. The objectives and research directions of the project have been established by a Five-Year Research Plan, which was developed at SERI in cooperation with the Department of Energy in 1984 and is divided into research on single-junction and multi-junction solar cells. DOE/SERI has recently initiated a new three year program to be performed in collaboration with US industry to perform work on high efficiency amorphous silicon solar cells and submodules. The objectives of this initiative are: (i) to achieve 18% efficiencies for small area multi-junction amorphous silicon cells, and (ii) to achieve amorphous silicon submodule efficiencies in the 10 to 13% range for single-junction and multi-junction submodule configurations over areas of at least 1000 cm^2.

37742 (STEV-EO—86-1) **Weed control in energy forest production.** Danfors, B. (Statens Energiverk, Stockholm (Sweden); Swedish Inst. of Agricultural Engineering, Uppsala). 1985. 27p. (In Swedish). (JTI—72). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752272.

The aim of the work was to collect, analyse and present experiences from mechanical and chemical weed control. The drainage status of the soil have to be good if mechanical control shall be used. Chemical weed control with soil-active herbicides requires less herbicide on mineral soils than on organic soils. Weed control must be started the year before planting the cuttings. The energy forestry plantation should be planted with the greatest possible precision to enable weed control between the rows. If weed control is neglected the energy forestry plantation will be unsuccessful. In all such plantations an intensive supervision of the weeds is required for the 2 first years. When the plantation has become established, the weed will have difficulties in competing with the energy plants. Seed-propagated weeds can be controlled if the entire area is sprayed with a soil-active herbicide immediately after the planting of the cuttings. Soils with different organic contents require different doses of herbicide. At present, research is being concentrated on preparing recommendations on doses for different soils. If the spraying with soil-active herbicides is unsuccessful there must be alternative forms of weed control. Weed control in growing stands protect the plants. After harvest the competitive conditions change radically for the weeds. There may now be justification in applying an early spraying before new shoots have developed. Granulated soil-active herbicides may be an alternative. Under favourable conditions the energy plantations is capable of growing faster than the weeds without the help of herbicides or mechanical weed control. Recommendations for the use of herbicides have been prepared for different situations. (BoK).

37743 (STEV-EO—86-4) **Economic analysis of energy forestry.** Loenner, G.; Parikka, M.; Soederberg, L. (Statens Energiverk, Stockholm (Sweden)). 1986. 79p. (In Swedish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752481.

The aim of this study has been to elucidate the economic potential of energy forestry in comparison to other alternative solid fuels and alternative land use. The analysis has been made to serve as a basis for the National Energy Administration considerations concerning a future introduction of energy forestry. The time perspective of the main analysis is 5 years. This analysis is based on existing technology. An analysis of the potentialities of energy forestry in a longer time perspective is also given.

37744 (STEV-SB—86-3) **Evaluation of 'bioashes' as forest fertilizers.** Moberg, P.O.; Tidestroem, H. (Statens Energiverk, Stockholm (Sweden)). Nov 1985. 102p. (In Swedish). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752274.

The aim of this project is to compare the competitive ability of bioashes with conventional fertilizers and lime within forestry and energy forestry. Plant nutrient content, alkalizing ability, pretreatment-, transport- and spreading costs are considered for different kinds of bioashes. Swedish areas suitable for bioash fertilization are estimated. Leaching of heavy metals and environmental effects are discussed. The investigation shows that the most profitable use of bioash is as a combined fertiliser/liming agent at the establishment of energy forest on peatland. If bioashes shall be able to compete with conventional fertilizers in forestry new methods for spreading of ungranulated ashes on the ground must be developed. (BoK).

37745 (STEV-SB—86-7) Needle litter in heaps of logging residues during a growing period. Flinkman, M.; Fredrikson, H.; Thoernqvist, T. (Statens Energiverk, Stockholm (Sweden)). 1986. 48p. (In Swedish). (SLU-IVL—174). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752485.

Since 1978 the Department of Forest Products has conducted research into the storage and handling of forest fuel of different kinds in the sequence from felling to combustion. The objective of this work was thus to illustrate in which form and intensity losses of matter occur in winter-felled logging residues which is stored in heaps on the clear-cut throughout a growing period. Conversely, it implies an indirect estimate of the amount of litterfall, i.e. needles, bark, branches and fines which loosen and fall off on the clear-cut in connection with the removal of heaps after storage for different periods. In 10 heaps the mean moisture content in May was ca 40% after which there was a reduction to 24% until early July. During July, August and September the moisture contents successively increased and throughout this three-month period averaged 33-36%. Subsequently, there was an increase during the autumn to 50-55% moisture content. The proportion of needles decreased considerably from 25% at the start to ca 2-3% at the end of the period, i.e., a decrease of more than 20 percentage points. At the same time the wood proportion increased by ca 15-20 percentage points. The proportion of bark and branches appears to have weakly increased whereas the proportion of fines has decreased slightly. The total proportion of these increased ca 3-6 percentage points and at the start made up 36% and at the end ca 40-41% of the total dry matter. In summary, it was found that the needle litter made up the largest relative loss of matter (more than 20%) in winter-felled heaps of logging residues which were stored throughout a growing period. In addition, about half of the total amount of needles which fall off during storage throughout a summer have fallen before the start of July.

37746 (STEV-TORV—86-7) Sampling of solid indigenous fuels in Finland. Status report. Impola, R.; Kallio, M.; Komonen, P.; Johansson, E.; Persson, J.Aa. (Statens Energiverk, Stockholm (Sweden)). Jul 1985. 85p. (In Swedish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752277.

The major reason for the quality control made when the peat is delivered is to determine the price of the peat. The price of the peat is determined by the calorific value, which is dependent of the amount of dry substance and the calorific heat value of the dry substance. A station for sampling and dry substance determination of milled peat described in this project is the first sampling equipment in Finland that takes its sample directly from a load. The station is a prototype made for research. The station is mobile, and is therefore possible to use at different quality control investigations made at power plants. During test runs the sampling equipment and the IR moisture meter was tested. When two samples were taken from the same load the difference in dry substance between the final samples was less then 0.5% in four loads out of five. The conclusion was that the precision of the mechanical sampling was better than the precision of the manual sampling because a larger number of partial samples were taken and the samples could be taken vertically through the whole load. The cost estimate showed that manual sampling, done both by producers and consumers in parallell, has a considerable salary cost. At present the research is concentrated upon quality determination of sod peat and wood chips, but this research also involves sampling. The interest for developing a standard for sampling of biomass fuels is growing. At the moment there exists a recommendation for definitions, determination and price-setting of wood fuels, which is not used in practice. During peat production each harvest is sampled after collection into peat piles. At peat delivery, samples are taken during loading or unloading or at the heating plant. In research cutting a notch is the most usual method. It is cumbersome and gives as its result the situation at a defined place. (author).

37747 (VTT-TUTK—373) Photovoltaic module performance in Finland, part 1. Anttila, E.; Leppihalme, M.; Lignell, E. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). Oct 1985. 48p. (In Finnish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752304.

Photovoltaic module testing under Finniah climate conditions was initiated in 1982. The modules under test are commercial, fabricated of two different cell-materials and mounted facing south in two different tilt angles. The solar radiation intensity on the module plane as well as on the horizontal phane are measured. The results suggest, that already in February and still in October enough solar energy for stabile electricity production is available. The storage and array capacity have to be sized large enough to carry the system over the dark winter period. Mounting the modules vertically does not seem profitable in latitude 60 degrees north.

37748 Ion-beam sputtered indium tin oxide for InP solar cells. Aharoni, H.; Coutts, T.J.; Gessert, T.; Dhere, R.; Schilling, L. (Solar Energy Research Institute, Golden, Colorado 80401). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 428-431(May 1986).

The efficiency of indium tin oxide/indium phosphide (ITO/InP) solar cells depends on the rate of deposition of the ITO and the substrate temperature. In the case of rf sputter deposition, both of these parameters should be maintained as low as possible. However, it is still necessary to produce ITO window layers with as low a sheet resistance and high a transmittance as possible. This paper is concerned with the properties of such films fabricated by ion-beam sputtering under the above restrictive conditions. In particular, we have investigated the effects of varying the background partial pressure of oxygen, the film thickness, and the rate of deposition on the electro-optical properties of the films. (i) For very slow deposition rates ($\sim$0.3 A s^{-1}) and low substrate temperatures ($<$40 °C), resistivities of $<7 \times 10^{-4}$ Ω cm have been obtained for films of thickness 250—1200 A. This was for a partial pressure of oxygen, $<10^{-6}$ Torr; for a partial pressure of 4×10^{-5} Torr, the resistivity of the films increased to 2×10^{-3} Ω cm. (ii) The refractive index increased from 1.95 to 2.00 over the same range of oxygen partial pressure. (iii) For very thin films, $<$200 A in thickness, the refractive index decreased to $\sim$1.75. (iv) Carrier mobility shows a transition from lattice scattering ($\mu \sim 25$ cm^2 V^{-1} s^{-1}) to impurity scattering ($25 < \mu < 15$ cm^2 V^{-1} s^{-1}) for a carrier density $n >$ or $\approx 3 \times 10^{20}$ cm^{-3}. (v) The optical constants vary significantly across the solar spectrum with oxygen partial pressure and film thickness.

37749 Effect of plasma exposure on the performance of indium tin oxide/InP solar cells prepared by radio-frequency and ion-beam sputtering. Naseem, S.; Coutts, T.J.; Aharoni, H. (School of Physics, Newcastle Polytechnic, Newcastle upon Tyne, England). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 465-469(May 1986).

Previous work has shown that the performance of p-type single crystal/n-type thin film indium tin oxide (ITO) solar cells, can be enhanced by exposing the substrates (InP) to a very low power rf plasma prior to deposition of the ITO and by depositing the ITO very slowly. The mechanism underlying this enhancement is the subject of this experimental investigation. The principal variables studied were the duration of the low power plasma exposure (LPPE), the doping density of the substrate, and the methods of depositing the ITO. Comparison of the cells has been made on the basis of their current/voltage characteristics and their quantum efficiency. The analysis is consistent with there being a thin n-type layer at the interface between the InP and the ITO. For the ion-beam deposited ITO, the n-type layer is vanishingly small but for the rf deposited cells it is 70—100 A thick; the thickness reducing with longer LPPE. The thickness of this layer appears to control the device performance; the cells with thicker layers have much larger open-circuit voltage and somewhat lower currents, whereas the reverse is true for thinner layers.

37750 Scanning Auger microprobe studies of ball cratered CdS/CuInSe$_2$ solar cells. Levenson, L.L.; Burnham, N.A.; Matson, R.J.; Noufi, R.; Kazmerski, L.L. (University of Colorado, Colorado Springs, Colorado 80933-7150). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1680-1683(May 1986).

CdS/CuInSe$_2$ solar cell films are typically several micrometers thick. Composition profiles of these films are usually carried

out on fracture cross sections by scanning Auger microscopy or by recording Auger spectra during ion milling. For fracture cross sections, the depth resolution depends on the electron beam diameter and the roughness of the fracture surface. Ion milling is time consuming, and artifacts are caused by ion beam faceting. Ball cratering requires only a fraction of an hour and provides significant magnification of the film cross section. There is sufficient contrast, both in optical and electron microscopy, to distinguish between CdS and $CuInSe_2$ layers. Auger line scans and point analyses across crater walls have been used to determine composition depth dependence. Artifacts associated with this technique are electron beam damage of CdS and $CuInSe_2$ during line scan analysis and smearing of CdS for short distances (~1 μm) along the crater wall during ball cratering.

37751 **New generation photovoltaic technologies.** Surex, T.; McConnell, R.D. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, CO 80401). pp 352 of Proceedings of Intersol 85. Ottawa, Ontario; SESCI (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper describes significant results arising from SERI's photovoltaic research efforts, both subcontracted and internal, for the fiscal years 1984 and 1985. The major highlights include the following: the start of four major, cost-shared subcontracts with Chronar, Solarex, 3M and Spire in amorphous silcon; the fabrication of state-of-the-art amorphous silcon cells and new knowledge obtained on amorphous silcon alloys by SERI scientists; Xerox's new information on light-induced degradation in amorphous silcon, the so-called Staebler-Wronski effect; an IR-100 award for the development of the $CuInSe_2$/Cd(Zn)S solar cell; Knudsen cell production of $CuInSe_2$ cells by the Institute of Energy Conversion; Chevron's materials purification efforts leading to reported 26% efficient GaAsSb concentrator cells; Varian's high efficiency AlGaAs cell; MIT's stacked CLEFT GaAs-Si cell; SERI's high efficiency GaAsP cell; research by SERI solid-state theorists on new semiconductor materials and ordered intermediate compounds (superalloys); application of Rockwell's electrochemical photocapacitance spectroscopy technique to amorphous silcon materials; SERI's novel silcon purification technique; SPIRE's and Westinghouse's 18% silcon solar cells; SERI's work on long-carrier-lifetime single crystal silcon; SERI's solar resource modelling algorithms and data collection efforts; and the evaluation of over 3000 samples of PV cells and materials and the development of a new materials analysis technique called volume-indexed secondary join mass spectroscopy (SIMS) by SERI researchers.

37762 **Thermally conductive silicone based materials for attaching concentrator solar cells to heat sinks.** Beavis, L.C.; Moss, M. (Sandia National Laboratories, Albuquerque, NM). pp 1-6 of Heat transfer - Denver 1985. New York, NY; American Institute of Chemical Engineers (1985).

The authors have application for low electrical conductivity-high thermal conductivity adhesives. The adhesive is to be used to attach a concentrator silicon solar cell to an aluminum heat sink. Early in the program they observed that commercially available adhesives did not achieve advertised thermal conductivities in minimum thickness layers. They ascribed the higher-than-expected thermal resistance to contact resistance. Therefore, they set about an experimental program to study the magnitude of contact resistance and the impact of varying the amount of thermally conductive additive to silicone-based adhesives. The thermal conductivity of freshly cured, unfilled silicone is about 0.05 $W\ m^{-1}\ K^{-1}$. With thermal cycling this value increases to about 0.2 $W\ m^{-1}\ K^{-1}$. The thermal conductivity of the material increases in a superlinear fashion with weight fraction of fill material. Thermal conductivities of 1 $W\ m^{-1}\ K^{-1}$ are achievable with 0.75 alumina by weight.

37763 **Direct conversion of biomass to liquids by thermal processes.** Stevens, D.J.; Schiefelbein, G.F. (Pacific Northwest Lab., P.O. Box 999, Richland, WA). pp 1-12 of Proceedings of the summer meeting of the American Society of Agricultural Engineers. St. Joseph, MI; American Society of Agricultural Engineers (1985). (CONF-8506232—). Contract AC06-76RL01830.

From American Society of Agricultural Engineers summer meeting; East Lansing, MI, USA (23 Jun 1985).

Biomass energy offers a high potential for energy impact in the United States. Liquid fuels are expected to be major contributors to this potential. Liquid fuel research sponsored by the U.S. Department of Energy's Biomass Thermochemical Conversion Program is described in this paper.

37754 **Procurement and marketing of forest residues.** Sawyer, W.C. (In-Forest Drying of Residue Chips, Gorham International Inc., Gorham, NC). pp 243-281 of Energy from biomass and wastes IX. Chicago, IL; Institute of Gas Technology (1985). (CONF-850104—).

From 9. annual symposium on energy from biomass and wastes; Lake Buena Vista, FL, USA (28 Jan 1985).

Forest residues from traditional logging operations on operable lots have historically left slash behind which equals 4-5 quads of renewable energy per year. If economical means were found to recover and chip these residues and markets for these chips were developed, the remaining half of U.S. forest lands which are now not operable could be economically thinned to increase their value and rate of growth. By this means the renewable residues available would increase to 7-8 quads of energy per year while remaining capable of supplying an increasing roundwood market. Integration of traditional roundwood logging with residue chipping to more economically produce both residue chips and roundwood is the subject of field work now being conducted in Maine under support from the U.S. Department of Energy - Office of Industrial Programs. In addition, one way of creating the required chip market is being developed as part of the same project. Equipment to dry chips in the forest employing chips to provide the required heat has been put in place. Also techniques for using dry chips so as to greatly reduce the capital costs at the user site are being developed.

37755 **Catalysts for biomass gasification.** Brown, M.D.; Baker, E.G.; Mudge, L.K.; Wilcox, W.A. (Pacific Northwest Laboratory, Richland, WA). pp 505-521 of Energy from biomass and wastes IX. Chicago, IL; Institute of Gas Technology (1985). (CONF-850104—).

From 9. annual symposium on energy from biomass and wastes; Lake Buena Vista, FL, USA (28 Jan 1985).

Pacific Northwest Laboratory under sponsorship by the U.S. Department of Energy has undertaken a project to determine the technical and economic feasibility of using catalysts to improve the gasification of biomass. Catalytic steam gasification can increase the gas yields, reduce char production, and virtually eliminate all tars over conventional gasification technology. Outlet gas compositions can be specifically tailored by altering catalysts and steam/biomass ratios or adding air to fluidizing medium. Recent bench-scale fluid bed studies have shown that catalyst/biomass contact during pyrolysis plays a strong role in catalyst deactivation. Short catalyst lifetime due to coke formation on the catalysts has been the major technical problem. Gasification in a two-stage fluid bed gasifier has shown long lifetimes for the catalysts. Gas yields have been 20% higher than calculated from previous laboratory studies.

37756 **An economic evaluation of the competitiveness of Short-Rotation Intensive Culture for energy.** Perlack, R.D.; Ranney, J.W.; Wright, L.L. (Environmental Sciences Division, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, TN). pp 1245-1263 of Energy from biomass and wastes IX. Chicago, IL; Institute of Gas Technology (1985). (CONF-850104—).

From 9. annual symposium on energy from biomass and wastes; Lake Buena Vista, FL, USA (28 Jan 1985).

The economics of SRIC are evaluated for a number of different regions and species utilizing many of the major findings reported from the Department of Energy's Short-Rotation Woody Crops Program. Estimated SRIC production costs are compared to current and projected prices of alternative fuels to determine the competitiveness of intensive woody biomass production. Results indicate that SRIC production costs will range from about $1.50 to $2.50 per GJ in the year 2000. To attain these costs it will be necessary to design and develop harvesting equipment that will reduce costs to $12 to $15 per dry tonne and to utilize genetic improvement programs and biotechnology to increase productivity and site

adaptability. It will also be necessary to demonstrate and verify experimental productivity rates and costs.

37757 **Some aspects of long-range, high-risk photovoltaic research at SERI.** Deb, S.K. (Solar Energy Research Inst., Golden, CO). pp 127-138 of Photovoltaics. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1985). (CONF-8504109—).

From SPIE technical symposium - East '85; Arlington, VA, USA (8 Apr 1985).

The work described in this paper includes some aspects of the long-range, high-risk research being conducted at the Solid State Photovoltaic Research Branch at SERI. The areas covered include: amorphous silicon, high efficiency, multijunction solar cells, CdS/$CuInSe_2$ thin films, crystal growth research and solid state theory. In each of these areas specific research projects which have long-range implications are highlighted in this review.

37758 **Cadmium telluride (CdTe) solar cells.** Zweibel, K.; Hermann, A. (Solar Energy Research Inst., Golden, CO). pp 119-126 of Photovoltaics. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1985). (CONF-8504109—).

From SPIE technical symposium - East '85; Arlington, VA, USA (8 Apr 1985).

Electric power generated by cadmium telluride (CdTe) polycrystalline thin-film solar cells may potentially be cost-comptetitive with power from conventional sources such as oil, natural gas, coal, and nuclear. The polycrystalline CdTe solar cell technology has recently achieved reported efficiencies of over 10% in several laboratories, and large-area cells can be deposited by several potentially low-cost methods. This paper describes cadmium telluride materials properties, electronic properties (especially doping and contacting), CdTe alloys and their potential usefulness, solar cell structures in which CdTe can be an important component, and the status of several efforts to optimize the performance of polycrystalline CdTe solar cells deposited by potentially low-cost technologies.

37759 **Current status of silicon materials research for photovoltaic applications.** Ciszek, T.F. (Solar Energy Research Inst., Golden, CO). pp 10-19 of Photovoltaics. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1985). (CONF-8504109—).

From SPIE technical symposium - East '85; Arlington, VA, USA (8 Apr 1985).

The desire for high solar cell efficiencies has been a strong factor in determining the course of recent silicon crystal growth research efforts for photovoltaics. This review, therefore, focuses on single-crystal, dislocation-free ingot growth methods (Czochralski growth, float zoning, and cold crucible growth) and on sheet growth technologies, generally multicrystalline, that have achieved moderately high (>13.5%) laboratory-scale efficiencies. These include dendritic web growth, growth from capillary dies, edge-supported pulling, ribbon-against-drop growth, and a recent technique termed crucible-free horizontal growth. Silicon ribbon crystals provide a favorable geometry and require no wafering, but they contain defects that limit solar cell performance. Growth processes, their current status, and cell efficiencies are discussed. Silicon material process steps before and after crystal growth are described, and the advantages of silicon are presented.

37760 **High-efficiency silicon solar cells - Opportunity and challenge.** Rohatgi, A. (Silicon Device Development, Westinghouse R & D Center, Pittsburgh, Pennsylvania). pp 20-28 of Photovoltaics. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1985). (CONF-8504109—).

From SPIE technical symposium - East '85; Arlington, VA, USA (8 Apr 1985).

Low-cost, high-efficiency solar cells are the key to large-scale applicability of photovoltaic systems. Recent calculations done by DOE/EPRI suggest that flat plate modules will require at least 15% efficiency at cost of ≈50 cents/watt in order to economically compete with conventional energy sources. Greater than 18% efficient solar cells will therefore be required to achieve this goal because once the cells are placed inside the module, there are additional losses due to reflection from the glass, inefficient packing factor, and mismatch approaches that have recently produced >18% efficient silicon cells and, secondly, to address some of the remaining issues and challenges that can improve our understanding further and lead to even higher efficiency silicon cells.

37761 **Characterization of CdZnS/$CuInSe_2$ thin-film solar cells.** Ahrenkiel, R.K. (Solar Electric Div., Solar Energy Research Inst., Golden, CO 80401). pp 9-18 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—). Contract AC02-83CH10093.

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The development of a low-cost but efficient photovoltaic device has been a prime goal of recent research. Achieving the Department of Energy's cost objectives probably requires a technology based on either polycrystalline or amorphous this films. It is doubtful that single-crystal technology will be cost-competitive for the one-sun residential flat-plate collector application in the forseeable future. In order to meet efficiency goals, devices have been designed to circumvent the expected short lifetimes and diffusion lengths of polycrystalline materials. In such materials, one expects the grain surfaces to be efficient recombination sites. Therefore, the minority carrier diffusion length may be limited to about a one-grain diameter, which typically is about one micron or less in evaporated films.

37762 **Understanding, operating, and testing fixed bed gasifiers.** Reed, T.B.; Levie, B.; Das, A. (Solar Energy Research Inst., 1617 Cole Blvd., Golden, CO 80401). pp 205-217 of Bioenergy 84. Volume 1. Bioenergy state of the art. Egneus, H.; Ellegard, A. London, England; Elsevier Applied Science Publishers (1985). (CONF-840605—).

From Bioenergy '84; Gothenburg, Sweden (18 Jun 1984).

Gasifiers for biomass are deceptively simple and over a million operated reliably to provide power during World War II. There has been an explosion of interest in gasifiers as a method of providing gaseous and liquid fuels from biomass, and a few of these are discussed. Yet there are relatively few reliable commercial gasifiers in the world and the number of "failed gasifiers" is large. The authors believe this is in part due to the lack of detailed understanding of the thermodynamics and kinetics of gasification as they relate to the nature of the fuel and the gasifier operating conditions. It is also due to the lack of accepted testing and measurement techniques. An oxygen/air gasifier produces optimum conversion efficiency when all the carbon and oils are converted to gas, but a minimum of the CO-H_2 are burned. This condition occurs at the "carbon saturation point". A series of carbon saturation phase diagrams are presented which show the oxygen/steam required for optimum gasification.

1406 Photovoltaic Power Systems

REFER ALSO TO CITATION(S) 37694, 37751, 37804

37763 **(DOE/CE/30701—T7) Design and construction of the SMUDPV2 1-MW photovoltaic power plant. Final report** I. Henss, R.R.; Hooker, D.W. (Sacramento Municipal Utility District, CA (USA); Stone and Webster Engineering Corp., Denver, CO (USA)). May 1986. Contract FC03-82CE30701;FC03-83SF11968. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011857.

The Sacramento Municipal Utility District (SMUD), with cofunding from the US Department of Energy (DOE), has designed, procured, installed, and initiated operation of an additional nominal 1000 kilowatt power generating facility as the second phase of its photovoltaic power plant project. The facility converts solar energy directly into electricity using flat plate photovoltaic modules which are mounted on modular single-axis tracking structures. The facility is located adjacent to the Rancho Seco Nuclear Generating Station, southeast of Sacramento, California. Design work for the second phase began in 1983 and the plant began operation in December 1985. Direct current power from the multiple tracking structures is converted to 12.47-kV alternating current power by solid state power conditioning equipment. Overall con-

version efficiency, sunlight to utility grid power, is predicted to be between 8 and 10 percent. The plant is expected to generate 2.6 million kWh annually. The capital cost of the plant was $10.9 million.

37764 **(DOE/CE/30701—T8) 1985 Plant performance SMUDPV1 1-MW photovoltaic power plant. Final report II.** Collier, D. (Sacramento Municipal Utility District, CA (USA)). Feb 1986. Contract FC03-82CE30701. 13p. NTIS, PC A02/MF 01; 1; GPO Dep. File Number DE86011858.

Computer simulations were conducted to predict plant performance based upon the PV1 system design and using Fresno typical meteorological year data. The system performance has been evaluated by comparing the predicted data to actual measured data for net ac and dc generation, plane of array insolation, plant availability, efficiency, operating and maintenance costs and revenue. Data are graphed for each month of 1985. (LEW)

37765 (ESA-SP—40, pp vp) **Experiences with solar power.** Kesselring, P. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Experience with solar thermal plants is reviewed. The component and subsystems development of the last decade and particularly the receiver, collector and heliostat field development is a technical success. Solar specific problems on the system and component level arose when off the shelf solutions of fossile fired plants were transferred uncritically. It is shown that concentrated solar radiation is a relatively cheap high quality fuel. Other uses than electricity generation are high temperature processes and the production of solar fuels and chemicals. A technical and economic comparison of solar thermal and photovoltaic electricity generation is made.

37766 **(SAND—86-2035C) Photovoltaic technology evaluation.** Boes, E.C.; Thomas, M.G. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 5p. (CONF-860874—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010467.

From 2. international photovoltaic science and engineering conference; Beijing, China (1 Aug 1986).

Photovoltaic power system technology is experiencing very rapid development. In order to maintain a current understanding of the status of this technology, the Photovoltaic Technology Evaluation Project conducts an on-going program of evaluating PV hardware at the component, subsystem, and full power system levels. This paper describes: the evaluation of PV power system performance for several major PV installations in the US; recent results from the component and subsystem evaluation activities in our Photovoltaic Advanced Systems Test Facility (PASTF); and development and application of PV power system models to better understand PV power systems' performance.

37767 **(SAND—86-7031) Proof of feasibility of a novel inverter for photovoltaic power conditioning.** Dickerson, A. (California Polytechnic State Univ., San Luis Obispo (USA)). Apr 1986. Contract AC04-76DP00789. 78p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012729.

The Dickerson inverter concept obtains a sinewave current from an array that is segmented into a number of subarrays. These subarrays are switched among the ac phases so that the current from a given subarray is continuous and each phase is connected at all times to one or more subarrays. The control scheme assures a unity power factor currrent with real-time adjustment to power-system disturbances. A proof-of-concept inverter has been operated into a three-phase power system, with the dc supplied from a motor-generator set plus regulators that closely simulated the current-voltage characteristics of a photovoltaic array. The performance for the inverter has been projected for a 480V, three-phase system at the 50 kVA level. Computer simulations showed 98% utilization of array power was possible with efficiency better than 98% and harmonic content of 18% without filtering. An analysis of filtering costs indicates that reduction to 5% can be achieved at under $0.003 per watt for typical central-station applications. A more complex configuration was also analyzed with results of 99% utilization, 8% harmonic content, and the same efficiency. The intended power range for these inverters is 50 to 250 kVA per unit. The cost to produce the inverter at the 50 kVA level in quantities of 1000 units is estimated to be $0.05 per watt.

37768 **University talent and the problems of photovoltaic technology, products and markets.** Annan, R.H. (US Dept. of Energy, Washington, DC). pp 2-5 of Photovoltaics. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1985). (CONF-8504109—).

From SPIE technical symposium - East '85; Arlington, VA, USA (8 Apr 1985).

The adage "America's business is business" certainly applies to the development of photovoltaics as part of this country's mixed but balanced energy sources. To be successful in photovoltaics, firms must make extensive capital investments. Funds are required to conduct research and development to create better technology - a critical aspect in a rapidly advancing field such as photovoltaics. Even greater investments are required for production lines - to produce quality products with high efficiency and high yield rates, at a reasonable cost. Finally, the dispersed nature and competitiveness of the international market mandates that significant investments be made in marketing. Successful companies will be those that can optimize all three of these key variables - technology, product, and markets.

1407 Solar Thermal Power Systems

REFER ALSO TO CITATION(S) 37694, 37738, 37765, 37801, 38065

37769 **(N—86-21577) Technology for Brayton-cycle powerplants using solar and nuclear energy.** English, R.E. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Feb 1986. 15p. (NASA-TP—2558; E—2761). NTIS, PC A02/MF A01.

Brayton cycle gas turbines have the potential to use either solar heat or nuclear reactors for generating from tens of kilowatts to tens of megawatts of power in space, all this from a single technology for the power generating system. Their development for solar energy dynamic power generation for the space station could be the first step in an evolution of such powerplants for a very wide range of applications. At the low power level of only 10 kWe, a power generating system has already demonstrated overall efficiency of 0.29 and operated 38 000 hr. Tests of improved components show that these components would raise that efficiency to 0.32, a value twice that demonstrated by any alternate concept. Because of this high efficiency, solar Brayton cycle power generators offer the potential to increase power per unit of solar collector area to levels exceeding four times that from photovoltaic powerplants using present technology for silicon solar cells. The technologies for solar mirrors and heat receivers are reviewed and assessed. This Brayton technology for solar powerplants is equally suitable for use with the nuclear reactors. The available long time creep data on the tantalum alloy ASTAR-811C show that such Brayton cycles can evolve to cycle peak temperatures of 1500 K (2240 F). And this same technology can be extended to generate 10 to 100 MW in space by exploiting existing technology for terrestrial gas turbines in the fields of both aircraft propulsion and stationary power generation.

37770 **(SAND—85-0970) Evaluation of Heliostat Characterization System for use at the Central Receiver Test Facility.** Maxwell, C.; Otts, J.V. (Technadyne Engineering Consultants, Albuquerque, NM (USA); Sandia National Labs., Albuquerque, NM (USA)). Jun 1986. Contract AC04-76DP00789. 48p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012634.

The Heliostat Characterization System is a new system that has been used to align and focus heliostats at the Central Receiver Test Facility, Sandia National Laboratories. This system produces results comparable to those obtained with the original focus and alignment system but is faster and requires less labor.

37771 **(SAND—86-0852) Application of RELAP4/MOD6 to analysis of solar-thermal power plants: control system modelling.** Byers, R.K. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 39p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011848.

A systems effects computer program may provide a convenient means of analyzing the transient response of solar-thermal plants. Many of the components in such plants are similar, or identical, to those used in nuclear power plants; therefore, the reactor thermal/hydraulics program RELAP has been modified for application to solar-thermal plant analysis. Because of the similarities, no great difficulties were anticipated, or encountered. However, many solar-thermal plant and experiment designs include an extensive system for automatic control, and the capabilities of the particular version of RELAP being used were very limited in this regard. Thus, it was necessary to include the capability of control system modelling in the code. We have modified RELAP4/MOD6 so that it is able to model control systems and subsystems, and their effects on overall system response. This was done in such a way that the basic numerical solution scheme in the code was not altered. This report documents the additions and changes to RELAP and its associated output processing code. The code runs on SNLA's CRAY1-S using CO5. This report includes an example of control function use, in the form of a test calculation for the Molten Salt Electric Experiment (MSEE) receiver. The results of the analysis agree reasonably well with data, and were obtained at a small expense in computer time; this version of RELAP, therefore, should be useful for more complete analyses of solar-thrmal systems designs.

37772 **Economic evaluation of solar thermal energy systems using a Levelized Energy Cost approach.** Williams, T.A. (Pacific Northwest Lab., Battelle Boulevard, Richland, WA). pp 845 of Proceedings of condensed papers of the 7th Miami international conference on alternative energy source. Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1986). (CONF-851201—).

From 7. Miami international conference on alternative energy sources; Miami Beach, FL, USA (9 Dec 1985).

This paper discusses a Levelized Energy Cost (LEC) approach to economic evaluations of solar thermal power plants. Economic evaluations of solar thermal systems can only be done correctly using a life cycle cost approach. The life cycle cost of a solar thermal plant will include the plants capital cost, total operation and maintenance costs, taxes, interest, and return on investment. The LEC approach can provide an economically correct treatment of these costs and an evaluation of alternative solar thermal power systems. General economic principles relating to LEC calculations such as the time value of money, discount rate, present value, and annualized cost are defined and explained. The appropriate use of LEC analyses in choosing between alternatives is discussed. A method for calculating the LEC of a solar thermal plant is presented. This method has recently been used within the U.S. Department of Energy in developing technology goals for solar thermal systems. Standard economic assumptions for solar thermal applications for use in the methodology described, and the required modifications to the assumptions for the analysis of different energy systems discussed. Ways to easily implement the LEC calculation on a microcomputer are given.

37773 **Long-term technology goals for solar thermal energy systems.** Williams, T.A. (Pacific Northwest Lab., Battelle Boulevard, Richland, WA). pp 355 of Proceedings of condensed papers of the 7th Miami international conference on alternative energy source. Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1986). (CONF-851201—).

From 7. Miami international conference on alternative energy sources; Miami Beach, FL, USA (9 Dec 1985).

This paper describes long term performance and cost goals developed for the solar thermal technology. These goals were developed in support of the U.S. Department of Energy's (DOE) solar thermal technology program and are intended to aid in planning research activities needed to make solar thermal energy an option which is both technically and economically attractive. These goals are revisions of the technology goals which originally appeared in DOE's draft 1985-1989 National Solar Thermal Technology Program Five Year Research and Development Plan (DOE 1984). Solar thermal technology goals are intended to provide targets, which when met, would result in the widespread usage of solar thermal technologies in the marketplace. Technology goals were developed for the middle to late 1990's time frame, and encompass both system level goals and component goals. System goals are energy price targets which must be met for solar thermal to be economically viable in a given market. Component goals are performance and cost targets for the primary elements of a solar thermal plant (concentrators, receivers, etc.) which would allow achievement of the system level goal. Component goals were developed based on considerations of improvements in component efficiency and cost which could be attained through further R & D. System goals are developed for electricity and Industrial Process Heat (IPH) applications. Component goals are developed for the central receiver technology, parabolic dish technology, and parabolic trough technology.

37774 **Momentum and energy exchange in a solid particle solar central receiver.** Hruby, J.M.; Falcone, P.K. (Sandia National Laboratories, Livermore, CA). pp 197-203 of Heat transfer - Denver 1985. New York, NY; American Institute of Chemical Engineers (1985). (CONF-850810—). Contract AC04-76DP00789.

From National heat transfer conference; Denver, CO, USA (4 Aug 1985).

The use of free falling, sand sized solid particles as a direct heat transfer medium in a solar central receiver is under investigation at Sandia National Laboratories, Livermore. A series of models has been developed to describe the particle-air momentum and energy exchange in such a receiver. The earliest models were developed to assess the technical feasibility of the concept, and the later models were developed to more accurately describe the exchange. Early models were one dimensional, and use a control volume consisting of particles and intervening air. Momentum and energy exchange models are combined at each level of complexity to describe the thermal processes in a cavity receiver.

37775 **Gas-particle flow within a high temperature solar cavity receiver including radiation heat transfer.** Evans, G.; Houf, W.; Greif, R.; Crowe, C. pp 220-225 of Heat transfer - Denver 1985. New York, NY; American Institute of Chemical Engineers (1985). (CONF-850810—).

From National heat transfer conference; Denver, CO, USA (4 Aug 1985).

The flow of air and particles and the heat transfer inside a heated, open cavity containing a falling cloud of 100-1000 micron solid particles has been modeled numerically. The model includes radiative transport within the particle cloud and two-way momentum and thermal coupling between the particles and the air. The flow field is assumed to be two dimensional with steady mean quantities. The PSI-Cell (particle source in cell) computer code is used to model the gas-particle interaction. The radiative transfer within the cloud is modeled using the method of discrete ordinates. An analysis has been made which includes the incident solar flux and the radiation transport among the cavity surfaces. Velocity and temperature profiles of the particles and the air have been predicted. The model has been used to examine the thermal performance of the solid particle solar receiver as a function of particle size, particle mass flow rate, particle scattering albedo, and incident solar flux.

37776 **Direct-contact condensers for solar pond power plants.** Fisher, E.M.; Wright, J.D. (Solar Energy Research Inst., Golden, CO). pp 8 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

Direct-contact condensers for an organic Rankine cycle solar pond power plant are compared with conventional shell-and-tube condensers. Three types of direct contact systems are evaluated: drop type, bubble type, and packed columns. Methods used in the design of the direct contact system are reviewed. Complete 5MW/sub e/ plants, including the solar pond, are designed for each

system, and their capitalized costs compared. Direct contact condensers were found to be considerably less expensive than shell-and-tube condensers. However, the auxiliary equipment needed to prevent the buildup of noncondensables and to control working fluid losses negated much of the cost savings. Also, the direct contact systems were less efficient. Thus no significant advantages were found for the direct contract condenser systems.

37777 **Aerowindows for central solar receivers.** Taussig, R.T. (Mathematical Sciences Northwest, Inc., 2755 Northup Way, Bellevue, WA 98004). pp 12 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—). Contract AC03-83SF11693.

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

The benefits of aerowindows for reducing heat loss and isolating the interiors of central solar receiver cavities have been investigated analytically. Air curtain technology is available now for this application. Actual losses need to be measured in a scalable experiement.

1408 Ocean Energy Systems

37778 **(PB—86-177607/XAB) OTEC (Ocean Thermal Energy Conversion) cold water pipe at-sea test program data analysis project. Pipe, platform, and environmental parameters data reduction and analysis.** Vega, L.A.; Nihous, G.C. (EG and G/Washington Analytical Services Center, Inc., Berkeley, CA (USA)). Aug 1985. 152p. NTIS, PC A08/MF A01.

The report documents the data reduction and analysis or interpretation of representative records and an accompanying report documents the assessment of computer models developed to analyze the structural response of cold water pipes (CWPs). The principal aim of the data interpretation phase of the study was to determine the causal relationship between the environment and the barge/CWP response and to provide the information required to assess the CWP computer models.

37779 **(PB—86-177615/XAB) OTEC (Ocean Thermal Energy Conversion) cold water pipe at-sea test program data analysis project. Users guide for the NOAA/ROTECF and NOAA/TRW computer models.** Vega, L.A.; Nihous, G.C. (EG and G/Washington Analytical Services Center, Inc., Berkeley, CA (USA)). Jun 1985. 152p. NTIS, PC A08/MF A01.

Additional guidelines for the use of the Cold-Water-Pipe computer models NOAA/TRW and NOAA/ROTECF are provided. The primary intent of these Additional Guidelines is to correct and upgrade the user manuals with Errata Sheets and to provide an updated listing of the source codes. It is recommended that users be familiar with the hydrodynamic and structural aspects of floating vessels and the representation of OTEC pipes as beams of equivalent structural properties.

37780 **(PB—86-177623/XAB) Model test of a generic shelf-mounted OTEC (Ocean Thermal Energy Conversion) platform. Final report.** Hansen, D.W.; Chakrabarti, S.K. (CBI Industries, Inc., Plainfield, IL (USA). Research Lab.). Jan 1985. 158p. NTIS, PC A08/MF A01.

A model test of a generic Ocean Thermal Energy Conversion platform was performed in CBI's wave tank. The basic model consisted of four vertical columns placed in a square configuration. This model allowed the study of wave cancellation and multiple scattering. The spacing of the columns influences the wave force and may minimize the force at a given (design) wave period. The variation of other model configurations from the baseline model consisted of square blocks of different heights representing the submerged power modules of OTEC. The modules of different heights produced different blockage to the incoming waves. These modules were solid or uniformly perforated. Thus, the same blockage could be achieved by two different sizes of solid or perforated modules. Most of the modules were totally submerged while one extended above the water surface. The purpose of the test was to study the effect of, at least, three parameters on the global wave forces on the platform: (i) the size, (ii) the type, and (iii) the location of the modules.

37781 **OTEC methanol-from-coal process plantship studies.** Richards, D.; Avery, W.H.; Francis, E.J.; Jones, M.; Heyer, B.; Kohl, A.L.; Rosemary, J.K. (The Johns Hopkins Univ., Applied Physics Lab., Laurel, MD). pp 10 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

The use of slowly cruising plantships to produce methanol, liquid hydrogen and ammonia could make the tropical oceans a virtually unlimited, renewable resource for world energy needs. OTEC methanol is particularly attractive because it can replace gasoline as a motor fuel and is the preferred fuel for high-efficiency fuel cells for power generation. In both applications, preliminary analysis indicates that costs will be comparable to (or possibly below) those projected for alternative energy sources. High plant availability is projected. The nominal 160-MWe OTEC plantship has a projected output of 1742 tonne/day of methanol from 1356 tonne/day of coal, with delivered product costs estimated to be commercially competitive. Excepting the molten salt gasifier and the water electrolysis plant, standard available commercial processes from prior land plant designs are 'married' to form a practical connected process chain in terms of mass flows and heat balances, and still greater integration with consequent reduction of equipment and costs is believed possible. Details of the processes and estimates of capital and product costs are presented.

37782 **Conceptual design of a 10 MW shore-based OTEC plant.** Stevens, H.C.; Gunens, L.; Panchal, C. (Argonne National Lab., Argonne, IL 60439). pp 6 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

A 1982 study of a 10 MW shore-based closed-cycle OTEC plant at Keahole Point, Hawaii is updated to reflect advances in technology that have occurred over the past two years. Design options that show promise for reducing the capital cost of the plant are presented and are less conservative than those used in the earlier study. The options studied include the heat exchangers, the number and size of the cold-water pipes (CWP), the materials and method of construction of the CWP, and the CWP deployment technique. In all cases, the new options are within modest extrapolations of the current state of the art. Thermal-hydraulic optimization codes have been developed and used to upgrade and improve the design, and to focus on those components where significant cost reductions are possible. The power system has been improved with more cost-effective heat exchangers and a more water-efficient design. In addition, the long cold-water pipe associated with a shore-based plant warranted improved design concepts that appear to lead to lower costs.

37783 **Theoretical analysis of condensation in the presence of noncondensable gases as applied to open cycle OTEC condensers.** Punchal, C.B.; Bell, K.J. (Argonne National Lab., Argonne, IL 60439). pp 8 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

A theoretical analysis was carried out for the open-cycle OTEC condenser. Interfacial temperature profiles, and gas concentrations in the axial direction were determined, and their effects on the rate of condensation studied. For the analysis, the vapor phase was modeled using diffusion equations for simultaneous heat- and mass-transfer processes, while the liquid phase was modeled using a falling film analysis. This analysis was then applied to a plate-fin condenser, and the effect of varying the fin density along the condenser lengths was investigated. General engineering aspects of heat-exchanger design are discussed for condensation of vapor mixtures in the presence of noncondensable gases.

37784 **Open-cycle ocean thermal energy conversion (OTEC) research: Progress summary and a design study.** Penney, T.; Bharathan, D.; Althof, J.; Parsons, B. (Solar Energy Research Inst., 1617 Cole Blvd., Golden, CO). pp 12 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

In 1980, the Westinghouse Corporation completed an extensive Claude open-cycle ocean thermal energy conversion (OC-OTEC) system design study. Since that time, the Solar Energy Research Institute (SERI) has produced concepts and data bases that have reduced the technical uncertainties associated with the evaporator and condenser design and performance, seawater sorption kinetics and gas removal systems, low pressure turbine design with novel materials, and low cost system containment and structural design. This paper describes an integrated system design case study using the improved data base and summarizes an assessment of the relative thermodynamic performance of advanced technologies, drawing parallels with Claude's early work in the 1930s. Projections from these latest advances imply that OC-OTEC systems can be cost effective in sizes less than 10 MW/sub e/. Analyzing the research needs for OC-TEC systems reveals that an experimental facility integrating all essential components of a system is required. This paper describes a facility for conducting advanced research and verifying cycle feasibility in terms of performance, reliability, and cost. The thermodynamic performance of this integrated design is projected using an analytical system model incorporating the highly coupled component interactions.

37785 **An experimental study of steam condensation on water in countercurrent flow in presence of inert gases.** Bharanthan, D.; Althof, J. (Solar Energy Research Inst., 1617 Cole Blvd., Golden, CO 80401). pp 11 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

Experimental results of investigating steam condensation on water in the presence of (noncondensable) inert gases at low temperatures and pressures relevant to open-cycle ocean thermal energy conversion (OTEC) systems are reported. Seven different condenser configurations were tested. The experimental data are correlated using a liquid flow fraction and a vent fraction to yield simple relationships of condenser performance over a wide range of test conditions. Performance maps and envelopes are provided for evaluating the relative merits of tested configurations. The height of transfer unit (HTU) for condensation ranges from 0.2 to 0.3 m among the various condenser geometries. Also reported are the pressure-loss coefficents for all the tested geometries.

1409 Solar Thermal Utilization

REFER ALSO TO CITATION(S) 37361, 37799

37786 **(CONF-830929—Vol.8-Pt.1) Progress in passive solar energy systems. Volume 8. Part 1.** Hayes, J.; Andrejko, D.A. (eds.). (Marlboro Coll., VT (USA); State Univ. of New York, Buffalo (USA)). 1983. Contract FG03-83SF11947. 1039p. American Solar Energy Society, 110 West 34th St., New York, NY 10001. File Number TI86000195.

From 8. national passive solar conference; Santa Fe, NM, USA (5 Sep 1983).

Numerous conference papers on the subject of passive solar energy systems are provided in this publication. Separate abstracts have been prepared for each paper for inclusion into the Energy Data Base. (BCS)

37787 **(DTH-LV-MEDD—167) Solar walls - measured and calculated.** Olsen, L. (Danmarks Tekniske Hoejskole, Lyngby. Lab. for Varmeisolering). Jul 1985. 265p. (In Danish). NTIS (US Sales Only), PC A12/MF A01. File Number DE86752095.

In this report, different types of passive solar systems are described in general (direct gain, solar wall, Trombe wall). The historical development of solar walls is briefly presented. The theoretical formulae for heat transfer is described, including heat conduction, convection and radiation. Solar radiation and transmission formulae is shown. The theory is used for calculating the solar transmission for different materials. The system of equations for solving the heat transfer through the walls is developed. For the purpose of validating the simualtion program of the solar wall an experiment is set up. Different solar walls are built into test cells. One of the solar walls uses movable insulation of expanded polystyrene beads. A double acrylic plate is used as cover. The other solar wall has a fixed insulation of white glasswool. A third and a fourth type have a selective absorber surface, and a single cover of glass. In the fourth type, the cavity at the outerside of the storage is filled with honeycomb. The solar wall systems have been provided with measuring equipment supplying information about temperatures, heat flow and solar radiation. The accuracy of the measurements is estimated. The measured data are compared with results from the simulation model, and a good agreement between measurements and calculations is achieved. It is concluded that a simulation model which provides realistic values of the performance of solar walls has been developed and is applicable for optimisation and dimensioning of solar wall systems.

37788 **(DTH-LV-MEDD—172) Thermosyphon solar heating system at Lyngby. Results and experience after 1 year measurements.** Oestergaard Jensen, S. (Danmarks Tekniske Hoejskole, Lyngby. Lab. for Varmeisolering). Jan 1986. 60p. (In Danish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752097.

This report deals with the experiences and conclusions from measurements made on a thermosyphon solar heating system for hot water supply. The design of the system, the measuring programme and the results of the measurements are described. Computer calculations have been made to test the performance under other conditions than the actual conditions during the measurements. Investigations have been made of how the performance is influenced by an electrical heating element at the top of the storage and other weather conditions. It has further been investigated why this system has a higher performance than a similar system with a pump at the solar collector loop. Finally economic calculations have been carried out to prove how profitable this solar heating system is.

37789 (ESA-SP—40, pp vp) **Passive and hybrid solar systems.** Hastings, S.R. (EMPA, Dubendorf, Switzerland). Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Passive solar systems are introduced. The four most common types of system are direct gain windows, air collectors, mass walls, and sunspaces. For each system type the concept, an example, design considerations, calculation methods, performance data, and suggested reading are presented. Conclusions are valid for central and to an extent for northern Europe.

37790 (ESA-SP—40, pp vp) **Transparent superinsulating materials: new aspects in solar technology.** Fricke, J. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Silica aerogel utilization in architecture is discussed. Silica aerogel is a solid inorganic material of high porosity with an open microstructure smaller than the wavelength of visible light. It is made from tetramethoxysilane, which is catalytically converted into an alcogel. Supercritical drying in an autoclave produces transparent aerogel tiles or translucent aerogel granulate. Aerogel has a small Young's modulus (1 to 10 million N/sq m) and can be mechanically loaded with 200,000 N/sq m. Evacuated aerogel provides excellent thermal insulation at 300 K (thermal conductivity 0.008 W/(m.K)) and this is suitable as a spacer in windows orovides excellent thermal insulation at 300 K (thermal conductivity 0.008 W/(m.K)) and this is suitable as a spacer in windows or in covers for passive solar systems.

37791 (ESA-SP—40, pp vp) **District heating by solar energy with heat storage.** Zinko, H. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Solar district heating in middle and northern European climates is discussed. Well performing collectors can easily be directly applied for producing 10% to 15% of the yearly energy needs in district heating systems. It can be shown that the introduction of small daily storage is benificial for the load management of the total system. This holds even more if long term storage is introduced for systems with solar fractions 30%. Solar energy systems with different types of storage and an economic outlook based on Swedish experience are outlined.

37792 (ESA-SP—40, pp vp) **Process heat applications.** Sizmann, R. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Conversion of solar energy into industrial process heat is discussed. The demand for industrial process heat energy exhibits distinct regimes of maximum usage: at medium temperatures, i.e., 300 C, and 1150 C. Solar radiation converted to process heat energy can be used as fuel saver but also for solar unique applications: direct absorption, uncommonly high temperatures, and photocatalytic promotion of thermochemical reactions. The fluctuating input causes logistics and materials problems. Thermochemical reactions under consideration for pilot tests are mentioned.

37793 (SERI/TP—252-2812) **Natural convection in an enclosure with discrete roughness elements on a vertical heated wall.** Shakerin, S.; Bohn, M.S.; Loehrke, R.I. (Colorado State Univ., Fort Collins (USA). Dept. of Mechanical Engineering; Solar Energy Research Inst., Golden, CO (USA)). Feb 1986. Contract AC02-83CH10093. 9p. (CONF-860805—7). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86004424.

From International heat transfer conference; San Francisco, CA, USA (17 Aug 1986).

Natural convection flow next to a heated wall with single and repeated, two-dimensional, rectangular roughness elements is studied numerically and experimentally. The objective is to determine how these roughness elements influence heat transfer rates from the wall. Each roughness element consists of a thermally conducting, horizontal cylinder of rectangular cross section attached to the heated, isothermal wall of an enclosure. The height of roughness is on the order of the boundary layer thickness. Dye flow visualization in water confirms the numerical prediction that the steady flow over these elements does not separate. Only at high Rayleigh numbers, when the boundary layer below the roughness is unsteady, is local instantaneous flow reversal observed. Although steady flow reversals near the wall are not predicted or observed, nearly stagnant regions are formed, particularly between closely spaced cylinders. The surface heat flux in these stagnant regions is relatively low, so the total heat transfer rate may be nearly the same as for a smooth wall in spite of the increased surface area.

37794 (SERI/TR—252-2718) **SERI Desiccant Cooling Test Facility. Status report. Preliminary data on the performance of a rotary parallel-passage silica-gel dehumidifier.** Schultz, K.J. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1986. Contract AC02-83CH10093. 59p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86004448.

This report describes the SERI Desiccant Cooling Test Facility. The facility can test bench-scale rotary dehumidifiers over a wide range of controlled conditions. We constructed and installed in the test loop a prototype parallel-passage rotary dehumidifier that has spirally wound polyester tape coated with silica gel. The initial tests gave satisfactory results indicating that approximately 90% of the silica gel was active and the overall Lewis number of the wheel was near unity. The facility has several minor difficulties including an inability to control humidity satisfactorily and nonuniform and highly turbulent inlet velocities. To completely validate the facility requires a range of dehumidifier designs. Several choices are available including constructing a second parallel-passage dehumidifier with the passage spacing more uniform.

37795 (STF—62A85017) **IEA Task VIII: Passive and hybrid solar low energy buildings. National report Subtask D Program and design phase.** Hestnes, A.G.; Monsen, P.; Jacobsen, T. (SINTEF, Trondheim (Norway)). Jun 1985. 49p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752315.

The report describes the work done in Norway under Task VIII, subtask D, of the International Energy Agency's solar, heating and cooling program, entitled Passive and Hybrid Solar Low Energy Buildings. The overall objective of the task is to accelerate the development and use of passive and hybrid heated and costed low energy buildings. Subtask D consists of the design, construction and evaluation of one or more buildings. This report describes the program and design phases of one or more buildings. This report describes the program and design phases of the Norwegian building projects planned under the subtask, and presents the final designs. There are two projects, both dwellings, and they are presently under construction. One is located in Trondheim and the other one in Oslo. They have both been planned by local design teams.

37796 **Solar radiant processing of gas-particle systems for producing useful fuels and chemicals.** Hunt, A.J.; Ayer, T.; Hull, P.; Miller, F.; Russo, R.; Yuen, W. (Lawrence Berkeley Laboratory, University of California, Berkeley, CA). pp 191-203 of Heat transfer - Denver 1985. New York, NY; American Institute of Chemical Engineers (1985). (CONF-850810—).

From National heat transfer conference; Denver, CO, USA (4 Aug 1985).

This paper reviews the research program at LBL studying direct radiant heating for the production of fuels and chemicals. The research is investigating the use of gas-particle suspensions to absorb concentrated sunlight to supply energy for endothermic chemical reactions. The goal of the research is to understand the optical, thermodynamic, and chemical processes in solar heated particle suspensions through a balanced program of analytical and experimental investigations. The use of small particles as solar absorbers is discussed and spectral extinction efficiencies are calculated from Mie theory for various particle sizes. An equation for calculating the heat transfer from a particle to the surrounding gas at arbitrary Knudsen number is developed. The experimental section outlines the current laboratory studies of direct radiant heating that utilizes a high intensity radiant source to simulate concentrated sunlight. Some preliminary experimental result are presented.

37797 **Effects of heating rate on solar thermal decomposition of zinc sulfate.** Raissi, A.T.; Antal, M.J. (Renewable Resources Research Laboratory, University of Hawaii, Honolulu, HI). pp 204-212 of Heat transfer - Denver 1985. New York, NY; American Institute of Chemical Engineers (1985). Contract AC03-84SF12200.

Studies of the solid phase decomposition of zinc sulfate as a function of solids' temperature, heating rate and the incident radiative heat flux are presented. The experimental results are obtained in a novel thermogravimetric analysis system. This apparatus employs an intense beam of radiant energy, derived from an arc image furnace, to rapidly heat the solid sample. The interpretation of new data (including heating rates in excess of 1000 K/min), and comparison to more conventional low heating rate results, reveal the role and effects of radiative heat transfer and rapid heating rates on the decomposition behavior of $ZnSO_4$.

37798 **Improved accuracy of solar energy system testing and measurements.** Waterman, R.E. (Vitro Corp.). pp 6 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—). Contract AC01-79CS30027.

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

This paper discusses a method for increasing the accuracy of information obtained during the testing of solar energy systems. The method, based on Kalman filtering, is illustrated through an example involving the testing of a solar energy domestic hot water system. The focus of the paper is on testing and measurement using

field deployed, unattended sensors, data loggers and microcomputers. Test situations such as this sometimes produce dissappointing results in spite of the use of sensors having relatively high accuracies. The appropriate use of simple linear filters that can be incorporated into the data logging software can make multiple site visits unnecessary and can sometimes compensate for inaccurate data. The example presented examines data analysis of the collector loop of a solar energy domestic hot water system in which measurements of flowrate and temperatures contain significant errors. It is shown that a simple linear filter can salvage this situation and produce highly accurate estimates of the system energy flows. Coresponding calculations are carried out by more traditional methods to illustrate their inability to properly handle multiple error sources.

1410 Solar Collectors And Concentrators

REFER ALSO TO CITATION(S) 37776

37799 **(DOE/CS/30636—1) [Thermal design techniques for masonry material]. Final report.** Johnson, P. (Alfred Univ., NY (USA)). Nov 1984. Contract AC02-81CS30636. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012314.

The premise upon which this investigation was based was that careful tailoring of the properties of ceramic materials, intended for use in solar energy application through control of fabrication processes would lead to the development of optimized materials resulting in increased performance of both passive and active systems. The obvious advantages of ceramic solar energy materials include: (1) low cost; (2) durability; (3) aesthetic values; and (4) high thermal mass. Particularly in active solar energy system applications the low thermal conductivity, low mechanical strength, weight, and high porosity of most traditional ceramic products represent potentially serious disadvantages.

37800 (ESA-SP—40, pp vp) **Solar systems with highly efficient collectors.** Vitt, B. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Seasonal performance data of solar thermal systems are reported. For southern and middle European climatic conditions, systems with constant operating temperature, two types of domestic hot water system, as well as a space heating system were evaluated. The results are related to the thermo-optical properties of the collectors. A heat pipe evacuated tubular collector was examined. The impact of the optimization of the selective absorber coating on performance was studied. It is concluded that optimized evacuated tube collectors can be used to generate heat at temperatures 200 C.

37801 **(SAND—86-0004C) Energy and availability transport losses in a point-focus solar concentrator field.** Stine, W.B.; Heckes, A.A. (California State Polytechnic Univ., Pomona (USA). Dept. of Mechanical Engineering; Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 7p. (CONF-860810—2). NTIS, PC A02/MF A01. File Number DE86010482.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

This paper presents the results of an experimental study of the losses in transporting thermal energy from a field of 114 point-focus solar collectors to a central thermal energy conversion system at the Solar Total Energy Project (STEP), Shenandoah, Georgia. Conduction and convection heat losses from the collector field piping and solar collector receivers and radiant energy losses from the solar collector receivers were measured. At normal operating conditions the steady state heat losses per unit of collector aperture area are 130 W/m^2 (41 Btu/h-ft^2). The thermal mass of the collector field was found to be 3.92 kWh/°C (7440 Btu/°F), which implies that 17% of the energy collected on a tyical day is used to warm the field piping to its operating temperature. The loss of availability from the collectors and the field piping shows that only 21% of the solar energy falling on the collector field is delivered to the power cycle for conversion into electricity.

37802 **Conclusions and recommendations for the testing of flat-plate solar collector thermal performance and durability.** Waksman, D.; Thomas, W.C. (Center for Building Tech., National Bureau of Standards, Washington, DC). pp 6 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

Efforts in the development of reliability/durability tests for solar collectors and their materials have been hampered by the lack of real time and accelerated degradation data that can be correlated with in-use conditions. In 1977, the Solar Collector Reliability/Durability Test Program was initiated at the National Bureau of Standards (NBS) to help generate the data required to develop methods for predicting the long term durability and reliability of flat-plate solar collectors and their materials. This paper summarizes the results obtained in this test program for full-size solar collectors. Recommendations are made regarding the use and limitations of thermal performance measurements and environmental exposure tests for assessing the durability of flat-plate solar collectors.

37803 **Heat transfer in a solar radiation absorbing molten salt film flowing over an insulated substrate.** Wang, K.; Copeland, R.J. (Solar Energy Research Inst., Golden, CO 80401). pp 8 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—). Contract AC02-83CH10093.

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

A numerical model was developed to investigate heat transfer through a laminar molten-salt film flowing downward over an insulated substrate, which receives intense and collimated radiative flux at the free surface side. The calculated results compared favorably with analytical results for a flat velocity profile. It was found that fluid opacity, which can be changed by adding blackeners to the molten salt, is an important factor in determining the temperature distribution across the film. The combination of a moderately opaque fluid and a black wall gives maximum temperature rise. The bulk temperature increases only marginally if, instead of aparabolic velocity profile, a flat profile is assumed, but the temperature distribution across the film is more uniform. The reduced flow velocity enhances the temperature rise at the expense of decreased radiation collection efficiency.

37804 **An overview of photovoltaic concentrator technology.** Arvizu, D.E.; Edenburn, M.W. (Sandia National Lab., Albuquerque, NM 87185). pp 9 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

Concentrator photovoltaics is one of several photovoltaic approaches that could, in the future, provide reliable commercial electric power at a cost competitive with conventional sources. Since the path to providing cost competitive energy is dependent on both the conversion efficiency of the system and its installed cost, concentrators feature a unique approach in that both of these areas are pursued simultaneously. Concentrator technology has been supported by the U.S. Department of Energy's Federal Program for nearly a decade. In that time several systems have been fielded and research has continued to push the development of high efficiency systems. This paper presents the current status and research direction of concentrator photovoltaic technology.

37805 **Effect of infrared irradiance on collector thermal performance.** Thomas, W.C.; Reed, K.A. (Mechanical Eng. Dept., Virginia Polytech. Inst. & State Univ.). pp 10 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—).

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

The thermal performance of collectors is affected by infrared irradiance exchange with the surrounding environment through

two mechanisms. Radiant exchange with the outer surface of the cover system affects thermal loss from collectors even with a cover system that has a small infrared transmittance. An additional direct infrared exchange between the absorber and surroundings can be significant for collectors with a nominal infrared transmittance through the cover system. Collectors tested indoors under solar irradiance simulators generally receive much higher levels of infrared irradiance than collectors operating outdoors. An analysis is made of the infrared transmitting characteristics of cover systems including materials such as plastics where the IR effect is more pronounced. The result is used to simulate the performance of a typical flat-plate collector with various cover systems and absorbers. The effect of variations in the infrared environment is compared to the effects expected from variations in other environmental parameters and was found to be of the same order in many cases. The results provided the basis for a recommendation that incident infrared irradiance should be measured in standardized tests when the results may be used to establish thermal performance ratings.

37806 **Progress on solar absorber selective paint research.** Moore, S.W. (Los Alamos National Lab., Los Alamos, NM). pp 68-76 of Optical materials technology for energy efficiency and solar energy conversion III. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1984). (CONF-840872—).

From SPIE annual technical symposium; San Diego, CA, USA (19 Aug 1984).

A considerable amount of effort has been expend by the Department of Energy (DOE) and by commercial interests to develop solar absorber selective paints; the goal is to develop an inexpensive, durable selective coating that has moderately good optical properties. This report is intended to focus on those research programs monitored by Los Alamos, the research efforts in progress at Los Alamos, durability evaluations, and the progress that has been made toward commercialization.

37807 **Effective antireflection coatings of transparent polymeric materials by gas-phase surface fluorination.** Jorgensen, G.; Schissel, P. (Solar Energy Research Inst., 1617 Cole Boulevard, Golden, Colorado). pp 116-122 of Optical materials technology for energy efficiency and solar energy conversion III. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1984). (CONF-840872—).

From SPIE annual technical symposium; San Diego, CA, USA (19 Aug 1984).

There is a dramatic need in solar energy collection systems for lightweight, inexpensive polymeric materials that exhibit improved performance and durability. One approach to altering the properties of polymeric materials, surface fluorination, is appealing because of its potential for low cost. The literature indicates that such properties as permeability, wettability, bondability, thermal stability, weatherability, and optical transmittance can be improved by treating the surface with gaseous fluorine. A gas phase fluorination reactor system (GPFRS) was designed, built, and used. The initial emphasis was on improving optical transmittance by having an effective antireflection coating form on the surface of a wide variety of commercially available transparent polymeric films. These included such materials as polypropylene, acrylic, polyacrylonitrile, highly cross-linked polyethylene, polyester, polycarbonate and polymethylpentene. Two techniques were used to quantify the effect of exposing the surface of the polymers to gaseous fluorine. Transparent films were characterized before and after fluorine exposure by specular transmittance measurements. Surface analysis of selected treated and untreated samples was accomplished by x-ray photoelectron spectroscopy and depth profiling. Surface analysis confirmed the deposit of fluorine at the surface and into the bulk of all specimens examined after treatment in the GPFRS. Optical measurements revealed substantial improvement in specular transmittance following surface fluorination of almost all materials considered. Increases in solar weighted specular transmittance as high as 4.6% were measured.

1420 Heat Storage

REFER ALSO TO CITATION(S) 37791

37808 (ESA-SP—40, pp vp) **Photochemical, electrochemical and thermochemical transformation and storage of solar energy: thermodynamic aspects.** Calzaferri, G. Nov 1985. NTIS, PC A11/MF A01.

In Solar energy 85: resources, technologies, economics.

Arguments of reversible and irreversible chemical thermodynamics are explained and applied to the transfer and storage of solar energy chemical and radiation potential. The key processes are identified as water splitting, carbon dioxide reduction and nitrogen reduction. Results on photochemical storage processes are reported.

15 GEOTHERMAL ENERGY

37809 **(DOE/CE—0156) Geothermal progress monitor report No. 9, June 1985. A decade of progress, 1974-1984.** (USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC. Geothermal Technology Div.). May 1986. 106p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86011740.

This issue - No. 9 - focuses on 10 years of progress in: geothermal research and development, geothermal leasing, and geothermal resource assessment.

1501 Resource Status And Assessment

REFER ALSO TO CITATION(S) 37403

1502 Geology And Hydrology Of Geothermal Systems

REFER ALSO TO CITATION(S) 37812

1503 Geothermal Exploration And Exploration Technology

37810 **(LBL—21254) Fracture detection and mapping.** Goldstein, N.E.; Iovenitti, J.L. (Lawrence Berkeley Lab., CA (USA); Thermal Power Co., Santa Rosa, CA (USA)). Mar 1986. Contract AC03-76SF00098. 8p. (CONF-860111—9). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011558.

From 11. workshop on geothermal reservoir engineering; Stanford, CA, USA (21 Jan 1986).

Because the costs of drilling, completing, and testing a well can be extremely high, it is important to develop better tools and methods for locating high permeability zones prior to drilling, and to develop better tools and methods for identifying and characterizing major fracture zones during the drilling and well testing stages. At the recommendation of the LBL Industry Review Panel on Geothermal Reservoir Technology, we organized and convened a one-day workshop this past July to discuss various aspects of DOE's current and planned activities in fracture detection, to review the geothermal industry's near-term and long-term research needs, to determine the priority of those needs, to disseminate to industry the status of research in progress, and to discuss the possibility of future joint research between industry and DOE. In this paper we present a brief overview of the workshop from the perspective of those who participated in it and provided us with written comments to a questionnaire that was distributed.

37811 **(LUTVDG-TVTG—3009-1-94) Temperature log as an indicator of permeable zones and fractures in wells.** Persson, A.P.G. (Lund Univ. (Sweden). Dept. of Engineering Geology). 1 Sep 1985. 98p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86752142.

The purpose of this report is to study the use of temperature logging as a way of describing and detecting different sections of a formation. Temperature logging has been carried out in boreholes

in connection to production and injection of water. Temperature surveys have been carried out in two types of boreholes. One borehole, Vaerpinge-1, was to be used in a geothermal plant and therefore installed with screens and gravel. The other one, LTH-1, was made as a test well, and performed as an open hole below the casing. The type of formations also differed. In the test well the injection water entered fractures and fractured zones of the formations. In the geothermal well, the permeable section of the formation consisted of an unconsolidated sandstone. The results from the production survey in Vaerpinge-1 gave no, or at least, very poor information about the formations. The injection survey, in the same well, gave clear indications of permeable sections. In the borehole LTH-1, the temperature was measured for about two months after shut-in. One of the fractured zones of the formation was seen on temperature log recorded as late as 1225 hours after shut-in. The temperature decline is studied and the time necessary for a certain temperature loss is presented. A flowmeter log was recorded during injection in one of the boreholes. The log confirmed the different sections of the formation detec- ted by the temperature survey. The recorded temperature values during the survey in LTH-1 have been compared with the results obtained by numerical simulation. It is concluded that temperature logging can give additional information about different sections of a formation surrounding a borehole. It is also shown that a combination of field measurements and numerical simulations can give additional information about different parameters of a formation. 26 refs. and 10 figures.

37812 **(UCRL—94566) Drilling investigations of crustal rifting processes in the Salton Trough, California.** Kasameyer, P.W.; Younker, L.W.; Newmark, R.L.; Duba, A.G. (Lawrence Livermore National Lab., CA (USA)). 1986. Contract W-7405-ENG-48;AC04-76DR00789. 8p. (CONF-8606129—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010979.

From DOSECC workshop on continental scientific drilling program; Rapid City, SD, USA (12 Jun 1986).

The paper describes the results of CSDP activities in the Salton Sea Geothermal Field (SSGF), concentrating on a shallow heat-flow survey, but also considering preliminary results from the Salton Sea Scientific Drilling Program (SSSDP). Whether the heat input rate to localized systems is high enough to account for the overall thermal budget of the Salton Trough is examined. (ACR)

37813 **A geological and geophysical appraisal of the Baca geothermal field, Valles Caldera, New Mexico.** Wilt, M.; Vonder Haar, S. (Lawrence Berkeley Lab., CA, USA). *Journal of Volcanology and Geothermal Research;* 27: No. 3-4, 349-370(Mar 1986). Contract AC03-76SF00098.

The Baca location No. 1 geothermal field is located in north-central New Mexico within the western half of the Plio-Pleistocene Valles Caldera. Steam and hot water are produced primarily from the northeast-trending Redondo Creek graben, where downhole temperatures exceed 260 C at depths of less than 2 km. Production is mainly controlled by fractures and faults that are ultimately related to activity in the Rio Grande Rift system. Two-dimensional gravity modeling indicates that the depth to Precambrian basement in Redondo Canyon is probably at least 3 km and may exceed 5 km in eastern parts of the caldera. Telluric and magnetotelluric surveys have shown that the reservoir region is associated with low resistivity and that a deep low-resistivity zone correlates well with the depth of the primary reservoir inferred from well data. Telluric and magnetotelluric data have also identified possible fault zones in the eastern and western sections of the production region that may form boundaries to the Redondo Creek reservoir. These data also suggest that the reservoir region is located at the intersection of lineaments that trend north-south and northeast-southwest. Magnetotelluric results indicate deep low resistivity at the western edge of the caldera which may be associated with deep hot fluids. On the basis of geophysical and well data, three estimates are made of reservoir dimensions. The estimates of the areal extent of the reservoir range from 10 to 30 km/sup 2/, depending on whether the Sulphur Creek or the Valle Seco area is considered to contain deep geothermal resources. 16 figs., 33 refs.

1509 Geothermal Engineering

37814 **(AD-A—166408/5/XAB) Coso monitoring program, January 1984 through September 1985. Summary report, January 1984-September 1985.** Bjornstad, S.C.; Edwards, E.M. (Naval Weapons Center, China Lake, CA (USA)). Jan 1986. 136p. (NWC-TP—6693). NTIS MF A01.

The Coso monitoring program is a continuing effort in support of the development of the Navy's geothermal resources within the Coso Known Geothermal Resource Area (KGRA). Data are presented on the monitoring of steam flow rates and temperatures, water levels in ponds and wells, water chemistry, temperature logs of shallow wells, and rainfall in the Coso Hot Springs Resort area. A weekly photographic essay of the mud pots and pools shows the variation of surface-water levels throughout the year.

37815 **(SGP-TR—91) Reservoir technology - geothermal reservoir engineering research at Stanford. Fifth annual report, October 1, 1984-September 30, 1985.** Ramey, H.J. Jr.; Kruger, P.; Horne, R.N.; Miller, F.G.; Brigham, W.E. (Stanford Univ., CA (USA). Stanford Geothermal Program). Sep 1985. Contract AS03-80SF11459. 62p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010931.

The objective is to carry out research on geothermal reservoir engineering techniques useful to the geothermal industry. A parallel objective is the training of geothermal engineers and scientists. The research is focused toward accelerated development of hydrothermal resources through the evaluation of fluid reserves, and the forecasting of field behavior with time. Injection technology is a research area receiving special attention. The program is divided into reservoir definition research, modeling of heat extraction from fractured reservoirs, application and testing of new and proven reservoir engineering technology, and technology transfer. (ACR)

37816 **Present status of hot dry rock technology.** Nunz, G.J.; Franke, P.R. (Los Alamos National Lab., P.O. Box 1663, Mail Stop J979, Los Alamos, NM). pp 567-568 of Proceedings of condensed papers of the 7th Miami international conference on alternative energy source. Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1986). (CONF-851201—).

From 7. Miami international conference on alternative energy sources; Miami Beach, FL, USA (9 Dec 1985).

The Hot Dry Rock Program is a research. development, and demonstration program whose overall objective is to develop and demonstrate the technology required for large-scale extraction of thermal energy from naturally heated crystal rock that does not contain enough free water to be economically productive of natural hot water or steam. The method being developed is the use of fluid pressure (hydraulic fracturing) to produce large cracks that connect two wells drilled into the hot rock, permitting cool water injected in one well to extract heat from the rock as it circulates through the system of cracks, and then be recovered through the second well as hot water -- under sufficient pressure to prevent boiling. The large-scale field experiments required to develop and demonstrate the Hot Dry Rock method of thermal-energy production have so far been conducted principally at Fenton Hill, about 35 km west of Los Alamos, New Mexico, USA. Operations at this site have two major purposes: first, to develop and demonstrate practical methods of creating and operating HDR systems of the type described above; and second, as a field laboratory to evaluate and improve downhole instruments, special equipment, and techniques for drilling, well completion, and fracturing, and to develop and test analytical methods for fractured reservoirs.

37817 **Energy extraction via downhole heat exchangers in flooded abandoned mines: Applications for district heating and cooling.** Karvelas, D.E.; Kaminsky, J.; Peters, E. (Argonne National Lab., Argonne, IL). pp 569-571 of Proceedings of condensed papers of the 7th Miami international conference on alternative energy source. Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1986). (CONF-851201—).

From 7. Miami international conference on alternative energy sources; Miami Beach, FL, USA (9 Dec 1985).

Groundwater heat-pump systems have been a popular technology in the northern latitudes (e.g., in Sweden, Norway, Canada, the United States) for many years. Water is pumped from wells, heat is extracted from the water with water chillers (heat pumps), and the water is then usually discharged to surface streams or back into an aquifer through an injection well. Such systems can save considerable money and energy for industrial and residential space heating when compared to other forms of heating (e.g., electric resistance, oil, or gas furnaces). More recently, large systems of subsurface heat storage and heat extraction have been investigated and successfully demonstrated for industrial uses, hospitals, office buildings, and community systems. These systems, however, are often limited by the rate at which groundwater can be pumped from the extraction wells where surface heat exchangers (SHEs) are used. Flooded and abandoned underground mines often contain vast quantities of water. Moreover, the mine workings are highly permeable and the water temperature is relatively constant (usually 10-20°C) throughout the year. Thus, flooded underground mines near high-energy-use sites have great potential as low-cost energy sources for DHC systems. The U.S. Department of Energy is currently sponsoring a research program to investigate the technological and economic feasibility of using downhole heat exchangers (DHEs) in flooded anthracite mines near Scranton, Pennsylvania, as an alternative to pumping mine water up to the surface heat exchangers. Pumping of mine water is eliminated with DHEs; however, the potential rate of heat exchange using downhole technology is not known.

1510 Direct Energy Utilization

REFER ALSO TO CITATION(S) 37817

1520 Geothermal Data And Theory

REFER ALSO TO CITATION(S) 38992

16 TIDAL AND WAVE POWER

1608 Wave Energy Converters

REFER ALSO TO CITATION(S) 38078

37818 **(NP—6752316) Study of a multiresonant oscillating water column for wave-power absorption.** Malmo, O. (Trondheim Univ. (Norway). Inst. for Eksperimentalfysikk). Jun 1984. 194p. NTIS (US Sales Only), PC A09/MF A01. File Number DE86752316.

An absorber for wave energy based on the principle of an oscillating water column (OWC) is studied experimentally in model scale. The results are interpreted by applying a simplified model which is developed. The design differs from the more conventional OWC, as it has a "harbor" in the front towards the sea. This harbor, which actually is a pair of walls protruding from the absorber, gives rise to several resonant frequencies. For this reason the device is named the multiresonant oscillating water column (MOWC). To reveal the physics of the problem the water column is described by a harmonic oscillator. If the water column is oscillated, it will set up waves in the harbor. The travelling wave reflected from the harbor mouth will arrive back to the water column at a phase angle relative to the oscillation velocity, which depends on the harbor length. The performance of the absorber and other characteristic quantities are determined experimentally for different geometries and under various conditions. Numerical results obtained by the boundary element method agree well with the experimental results. 41 references.

17 WIND ENERGY

REFER ALSO TO CITATION(S) 38078

1703 Regulations

37819 **Addresses of: 1. Producers and dealers of wind turbines and wind turbine blades in the Netherlands. 2. Bureaus, institutions and associations in the field of wind energy.** Curvers, A.; Vanhulle, F. Patten, Netherlands; Netherlands Energy Research Foundation (1985). 24p. (In Dutch).

The state of affairs in April 1985 concerning the supply in the Dutch wind energy market is presented.

1704 Economics

REFER ALSO TO CITATION(S) 37820, 37827

1706 Wind Energy Engineering

REFER ALSO TO CITATION(S) 37819

37820 **(AD-A—165617/2/XAB) Review report on design study and economic assessment of multi-unit offshore wind energy conversion systems applications.** Bodey, C.E. (Naval Facilities Engineering Command, Washington, DC (USA). Chesapeake Div.). 21 Mar 1977. 44p. (CHES/NAVFAC-FPO—1-77(35)). NTIS, PC A03/MF A01.

This report reviews the Westinghouse Advanced Systems Technology Report. The review is responsive in providing Ocean Engineering support to ERDA on Wind Energy Conversion System (WECS) studies. The report addresses several fundamental issues that are apparent at this stage of the Westinghouse WECS study. These are: adequacy of the study plan and project management to support the ERDA objectives, and adequacy of the submitted final reports (Tasks B and C) to support the other Task studies. Based on the overall review, specific recommendations are made with respect to the two Westinghouse reports on a task-by-task basis. References and attachments are included.

37821 **(NP—6752268) FC-windpump project.** Stewart, H.; Karottki, R. (Danish Centre for Renewable Energy, Hurup Thy). 1985. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752268.

FC - the Danish Centre for Renewable Energy - develops renewable energy systems for local production. The following report on the FC-windpump project presents the backgground, technical concept and perspectives for water-pumping and electricity production with small-scale windmills, aiming especially at the needs of many 3rd world countries. FC-technologies provide possibilities for the promotion of local industries and trade through the development of renewable energy systems which are presented in the form of "builders handbooks" comprising full technical drawings and a text to assist in planning and production. (author).

37822 **(RISO-M—2562) Electric windmill-generators. Characteristics, adaptation and control.** Krabbe, U. (Risoe National Lab., Roskilde (Denmark)). Feb 1986. 121p. (In Danish). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752473.

The basic subjects of the present book are: 1) The theory of the asynchronous generator. 2) Calculations of performance of the asynchronous generator including a computer-programme for calculation of the torque, the losses, and the reactive power. 3) Control of grid-connected asynchronous generators. 4) Control of power, voltage and/or frequency of capacitor-excited asynchronous generators. 5) Analysis of battery-chargers fed from windmill-driven synchronous generators with permanent magnet excitation.

37823 **(STEV-VIND—86-2) Simplified analysis of the forces and movements of the Axel Egnell-turbine.** Dahlberg, J.Aa. (Aeronautical Research Inst. of Sweden, Bromma; Statens Energiverk, Stockholm (Sweden)). Sep 1985. 50p. (In Swedish). (FFAP—114). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752280.

The calculated relations are to be considered estimations because of the simplified analysis. It is shown that two turbine blades have completely different models of movements: one blade has low angles of grip and renders maximum effect at a wing tip speed which lies immediately below wind speed, the other blade acting sluggish at large grip angles and has its maximum effect at a speed which is 75% lower than the best number of revolutions of blade one. Both blades have a rigid connection and rotate round a common shaft. The performance of a horizontal axis turbine with the same blade design as above has been calculated. Large blade angles will render maximum effects which are 3 times higher than the effect of the Axel Egnell turbine. Low and suitable blade angles will give a low starting torque and a maximum effect which is 7 times higher. (G.B.).

37824 **(STEV-VIND—86-3) Wind power station with variable speed. A preliminary study.** Ulen, E. (Statens Energiverk, Stockholm (Sweden); Foersvarets Forskningsanstalt, Stockholm (Sweden)). Nov 1985. 127p. (In Swedish). (FOA-C—20591-E3). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752281.

This report is a preliminary study of the control problems when changing to variable speed that has been discussed for the serie version of WTS-3. It can be used for planning of future development of means for analysis and simulation. A simplified blade control in combination with electrical control of the generator is assumed. Rather big space has been devoted to more detailed study of the electrical control. The total system has been treated more superficially and more optimal solutions have referred to a continuation. (author).

37825 **(VTH-M—53) Design method for the calculation of performances and flap movement of flexible wind turbine blades.** Vanholten, T.; Kooman, J.L. (Technische Hogeschool Delft (Netherlands)). Feb 1983. 42p. (In Dutch). NTIS, PC A03/MF A01.

Performances, flap movements and loads of so-called flexible wind turbine blade were calculated in cases of right flow, flow with a velocity gradient, and oblique flow. The helicopter rotor based calculation method is simplified, and proves useful for first design estimates. The blades are schematized into intransformable blades attached to the hub using hinges with a spring stiffness such that the rotating natural frequency of the model blade flap movement is equal to the real blade natural frequency.

37826 **(VTH-M—84) Output calculations of the GIRO-MILL wind turbine.** Vanbussel, G.J.W. (Technische Hogeschool Delft (Netherlands)). Sep 1983. 29p. (In Dutch). NTIS, PC A03/MF A01.

Based on test data from a wind turbine test field, the performance of a three bladed vertical axis wind turbine with a cyclic blade angle adjustment was calculated. The effect of the replacement of a 1000 rpm generator by a 750 rpm generator on the output of an erected turbine is calculated. The modification is considered to reduce vibration. The effect of revolving variations on the output is examined. The losses of power are high. An increase of power seems possible if design modifications, such as the switching-off of the adjustment mechanism during normal operation, are carried out.

37827 **Review of US wind energy.** Divone, L.V. (US Dept. of Energy). pp 17-32 of Wind energy conversion - 1984. New York, NY; Cambridge Univ. Press (1984). (CONF-8403153—).

From 6. wind energy conference; Reading, UK (28 Mar 1984).

This paper describes the commercial development of wind farms in the US. The progress of the US Federal Wind Program is reported. Topics considered include tax credits, the fatigue life of wind turbines, funding, and the primary research and technology areas.

20 ELECTRIC POWER ENGINEERING

REFER ALSO TO CITATION(S) 38130

37828 **(ORNL/TM—10042) Rural electrification in Bangladesh: management, engineering, and financial assessment.** Deverick, B.; Gellerson, M.; Stovall, J.; Shelton, R. (Oak Ridge National Lab., TN (USA)). Jul 1986. Contract AC05-84OR21400. 124p. NTIS, PC A06/MF A01; GPO Dep. File Number DE86012457.

This report represents the partial findings of a five-member, multidisciplinary team requested by USAID to assess the progress of the Rural Electrification Program in Bangladesh. Four areas are assessed in this report: the effectiveness of the management system; the system planning and engineering capabilities; RE tariffs and energy sector pricing policies; and the effectiveness of technical assistance.

2001 Power Plants And Power Generation

REFER ALSO TO CITATION(S) 37357, 37371, 37371, 37708, 38074, 38129, 38132, 38202, 38536, 38752

37829 **(CONF-860535—1) Modeling of mineral matter behavior in coal-fired gas turbines, October 1, 1985-September 30, 1986.** Ahluwalia, R.K.; Im, K.H. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012122.

From 3. annual heat engines contractors' meeting; Morgantown, WV, USA (6 May 1986).

The objective of this task is to develop analytical models for establishing the relationship between the contaminants released from coal combustion and the resulting corrosion, erosion, and fouling of coal-fired gas turbines. The models are to be used for assessing the influence of operating variables such as coal cleaning, slurry composition, turbine inlet temperature, and blade cooling on the turbine performance. 5 refs.

37830 **(DOE/ET—15425-T1) Compressor configuration and design optimization for the high reliability gas turbine.** Boenig, F.H.; Day, D.L. (United Technologies Corp., East Hartford, CT (USA). Pratt and Whitney Aircraft Engineering Div.). Apr 1980. 54p. NTIS$8.00.

With high reliability and low electricity cost as the major design considerations, UTC defined three advantages of large industrial gas turbines - fewer stages, fewer parts, and high aerodynamic loading capability - and developed and evaluated a compressor configuration compatible with the reliable advanced liquid-fueled engine being researched by the electric Power Research Institute and the US Department of Energy for power-plant applications. A preliminary optimization study led to the selection of one candidate as high-throughflow configuration; the candidate represented the only configuration that could satisfy the physical restraints of the reliable engine design while showing the most potential for minimizing the power plant's cost of electricity. The compressors has nine stages, a 14:1 pressure ratio, and a predicted adiabatic efficiency of 88.35%. The diffuser, which was designed to decelerate the flow from the compressor exit to the combustor with a minimum total pressure loss, is a conventional straight-wall configuration with an equivalent conical angle of 8°. An alternative diffuser was also recommended because of its excellent performance potential in high-Mach-number applications.

37831 **(STEV—1986-1) Small scale heat and power generator. Technical development. Potential for power production.** (Statens Energiverk, Stockholm (Sweden)). 1986. 85p. (In Swedish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752480.

This is a review of the technology and economics of small units (less than 25 MWe) for coproduction of heat and electric power. Technologies of interest for the 1990's include steam- and gas turines and large internal combustion engines. On a longer timescale, the following options are of interest: fuel cells, small in-

ternal combustion engines, stirling engines, steam engines and ORC plants. (L.E.).

37832 (TKK-KO/ET—2) Methods to improve heat transfer in falling film evaporators. Fagerholm, N.-E.; Kivioja, K.; Ghanzanfari, A.-R.; Jaervinen, E. (Helsinki Univ. of Technology, Otaniemi (Finland). Inst. of Energy Engineering). 1985. 48p. (In Finnish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752110.

The validity of the theories was evaluated experimentally with the test rig built in the laboratory. Refrigerant R114 was used as the fluid to be studied. The refrigerant was flowing down as a falling film on the outside of a vertical test tube evaporating partly. Hot water flow inside the test tube was used as the heat source. The measured heat transfer coefficient for smooth tube varied from 1000 to 1800 W/m²K when the flowrate was Re = 1300-11000 respectively. During this surface evaporation mode the heat transfer could be predicted within +-5% with the experimental correlations of Chun and Seban. During nucleate boiling the heat transfer could be predicted within +-8% with the pool boiling correlation of VDI-84. The augmentation of heat transfer was studied by testing the performance of four structured-surface tubes: Gewa-T, High Flux, Thermoexcel-E and EC. A sand-blasted tube was also tested for comparison. The experiments revealed that although with this kind of minor changes of surface considerable enchancement is gained it cannot compete with the special surface structures. The enchancement obtained with the commercial surfaces was nearly of the order of magnitude bigger. When compared with smoot tube the best one Thermoexcel-E had 13 times and the poorest one High Flux 8 times better performance. Common trend with all these tubes was that the rate of enhancement decreased with increasing heat flux. The structured-surface tubes have been used in industry nearly 15 years.

37833 (TKK-KO/ET—3) Experimental study of heat transfer to falling liquid films. Fagerholm, N.-E.; Kivioja, K.; Ghazanfari, A.-R.; Jaervinen, E. (Helsinki Univ. of Technology, Otaniemi (Finland). Inst. of Energy Engineering). 1985. 41p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752113.

This project was initiated in order to obtain more knowledge about thermal design of falling film heat exchangers and to find methods to improve heat transfer in film flow. A short literature survey of film flow characteristics and heat transfer is presented. An experimental apparatus designed and built for studying falling film evaporation is described. The first experiments were made with smooth Cu tube 25/22 mm and refrigerant R114 as evaporating liquid. A significant amount of droplet entrainment was observed during the tests. The measured average heat transfer coefficient varied from 1000 to 1800 W/m²K when Re=1300 to 11000 respectively and when the transfer mode is surface evaporation. This could be predicted accurately with the experimental correlation of Chun and Seban. When nucleate boiling is dominant the heat transfer could be predicted well with pool boiling correlation of VDI-84.

37834 (TKK-KO/ET—4) Using structured surfaces to enhance heat transfer in falling film flow. Fageholm, N.-E.; Kivioja, K.; Chazanfari, A.-R.; Jaervinen, E. (Helsinki Univ. of Technology, Otaniemi (Finland). Inst. of Energy Engineering). 1985. 41p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752114.

The heat transfer performance of an ordinary roughened (sand-blasted) surface and four commercially available structured surfaces were tested with falling film flow arrangement. The commercial surfaces were: High Flux (Union Carbide), Gewa-T (Wieland) and Thermoexcel-E and -EC (Hitachi). The test evaporator consisted of a jacket and a single, vertical 2 m long test tube. The evaporating liquid flowed down on the outside of the test tube. The tests were conducted with refrigerant R114 at evaporation temperature of 23 deg C. In the fully developed region (x>0.4-1.0 m) the flow was distorted due to strong nucleation and droplet entrainment. At higher evaporation rates (>35-45%) the bottom parts of the test tube were not properly wetted and the heat transfer coefficient decreased although no permanent dry patches were yet seen. Nucleate boiling was dominant at all het fluxes tested with the commercial surfaces. No boiling hysteresis was observed. They all showed excellent performance, the best one (Thermoexcel-E) having 12 times better heat transfer than smooth tube. When heat flux was increased they all showed similar trend: the obtained enchancement compared to smooth tube was reduced. The sand-blasted tube could not compete with the structured surfaces. Its behaviour was more like smooth tube. During surface evaporation its performance was 1.4 to 1.8 times and during nucleation 1.7 times higher than smooth tube values.

37835 (TKK-KO/ET—6) Heat transfer and pressure drop of boiling R114 in a horizontal tube. Fagerholm, N.-E.; Ghazanfari, A.-R.; Kivioja, K. (Helsinki Univ. of Technology, Otaniemi (Finland). Inst. of Energy Engineering). 1985. 56p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86752115.

Datas on boiling and critical heat flux of R114 in a horizontal tube with high heat flux are reported. Some aspects of non uniform heat flux around the perimeter of tube are discussed. Comparison of some correlations for forced convective region has been made. The effect of vapor mass fraction on local heat transfer coefficient in the transition from bubbly to annular flow under high heat flux is shown. Martinelli-Nelson's method has been expanded for R114. The results of calculation of friction and acceleration pressure drop according to homogeneous and separated models and comparison with some of our data are included at the end of this report. None of the correlations considered can predict well for the whole range of variation of mass flux and heat flux. Relative good prediction of homogeneous model even at high vapor mass fraction suggest that for fluids like refrigerants with very low conductivity, the annular flow pattern may not materilize, but mostly dispersed with large amount of entrained droplets which are travelling with almost the same speed of vapor and that is the reason why homogeneous model's prediction is good. Very large effect of heat flux on pressure drop was found so there seems to be a need to study this aspect thoroughly. There is also no advantage of specifying the two phase viscosity in homogeneous model in any other way than (etasub(tP)=etasub(fO)) or fsub(tP)=fsub(fO).

37836 (VTT-TUTK—371) Emissions from wood and peat fired district heating plants. Vesterinen, R.; Paakkinen, K.; Pyykkoenen, M.; Virkki, J. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). Oct 1985. 142p. (In Finnish). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752303.

Emissions from ten district heating plants and a 0.5 MW pilot combustion plant were measured, all using peat and wood fuels. In six of the plants the fuel used was wood, either as chips, or as waste from the timber-processing industry. In two of the plants the fuel was milled peat, and in two sod peat. Flue gas cleaning was by multi-cyclone except in the gasification combustion plant and the 400 kW wood chip heating plant, in which there was no cleansing at all. The flue gases from the plants were metered for dust, carbon monooxide, carbon dioxide, total hydrocarbon, nitrogen oxides, as well as for polycyclic hydrocarbon emissions. In nearly all the plants the dust content of the flue gases was less than 500 mg/m³. Milled peat burning on a grate gave the highest dust emissions. The dust emissions of the wood chip burning plant were smaller than those of the plant using sawmill waste. The dust emission from sod peat burning was less than from milled peat. The nitrogen oxide emission NOsub(x) calculated as NO was less than 100 mg/MJ, in other words it was between the NOsub(x) emissions from the combustion of oil and natural gas. The nitrogen oxide emission from peat burned on a grate was slightly greater than that of wood burning. The nitrogen oxide emission from cyclone or gasification combustion was two or three times that of grate-burning. The hydrocarbon and polycyclic aromatic hydrocarbon emissions from the district heating plants were small.

37837 Simplified IGCC with hot fuel gas combustion. Horner, M.W. New York, NY; American Society of Mechanical Engineers (1985). 9p. (CONF-851005—).

From IEEE-ASME-ASCE power generation conference; Milwaukee, WI, USA (20 Oct 1985).

Experimental testing and data analysis performed for simulated simplified IGCC system components have been completed.

Earlier papers presented the program description and preliminary testing operations. This paper presents a review of the testing accomplishments and the results of data analysis. An air blown, fixed-bed coal gasifier, and downstream cyclone particle separator were found to retain or remove coal ash particles and alkali metals very effectively. The low calorific fuel gas delivered to a gas turbine combustor was found to be significantly closer to the current "clean fuel" specification than had been anticipated. These results are very encouraging for the further development of simplified IGCC systems utilizing hot gas cleanup. Observed ash deposition rates imply that turbine cleaning would be less frequent by at least an order of magnitude as compared to operation on treated ash-forming petroleum fuels.

37838 **Power generation through coal gasification an overview of DOE-funded projects.** Halow, J.S. New York, NY; American Society of Mechanical Engineers (1985). 10p. (CONF-851005—).

From IEEE-ASME-ASCE power generation conference; Milwaukee, WI, USA (20 Oct 1985).

The U.S. Department of Energy is currently sponsoring a variety of projects aimed at developing advanced systems for power generation using coal gasification as the central conversion process. These systems include both gas turbines and fuel cells as power generating devices and emphasize hot gas cleanup for equipment protection and environmental control from coal contaminants. Gasification projects in the DOE program cover a range of scales from laboratory investigations to PDU scale plants. Fundamental studies of gasification reactions, ash chemistry, transport processes, and modeling are being conducted to uncover potential improvements that may be made to gasification processes and to ways of reducing cleanup burdens on downstream equipment. Several PDU scale projects are being sponsored to further promising processes. Gas stream cleanup emphasize hot control of particulates, sulfur, alkali, and trace species which may damage power generation equipment. A systems approach has been adopted in formulating strategies for these programs. This approach and brief description of projects in gasification and cleanup is presented.

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REFER ALSO TO CITATION(S) 37312, 37316, 38531, 38679, 38796, 38797, 38801, 38802, 38815, 38862, 38863, 38869, 38922

37839 **(DOE/EP/12067—H1-Summ.) Utility FGD [flue gas desulfurization] survey, October-December 1984. Project summary.** Melia, M.T.; McKibben, R.S.; Jones, F.M. (PEI Associates, Inc., Cincinnati, OH (USA)). Jul 1985. Contract AC01-82EP12067. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012392.

The Utility FGD Survey report, which is generated by a computerized data base management system, represents a survey of operational and planned domestic utility flue gas desulfurization (FGD) systems. It summarizes information contributed by the utility industry, system and equipment suppliers, system designers, research organizations, and regulatory agencies. The data cover system design, fuel characteristics, operating history, and actual system performance. Also included is a unit-by-unit discussion of problems and solutions associated with the boilers, scrubbers, and FGD systems. The development status (operational, under construction, or in the planning stages), system supplier, process, waste disposal practice, and regulatory class are tabulated alphabetically by utility company. Simplified process flow diagrams of FGD systems, definitions, and a glossary of terms are attached to the report. Current data for domestic FGD systems show 126 systems in operation, 24 systems under construction, and 65 systems planned. The current FGD-controlled capacity in the United States is 49,574 MW.

37840 **(DOE/EP/12067—H1-Vol.1) Utility FGD [flue gas desulfurization] survey, October-December 1984. Volume 1. Categorical summaries of FGD systems.** Melia, M.T.; McKibben, R.S.; Jones, F.M. (PEI Associates, Inc., Cincinnati, OH (USA)). Jul 1985. Contract AC01-82EP12067. 367p. NTIS, PC A16/MF A01; 1; GPO Dep. File Number DE86012651.

The Utility FGD Survey report, which is generated by a computerized data base system, represents a survey of operational and planned domestic utility flue gas desulfurization (FGD) systems. The two volume set summarizes information contributed by the utility industry, system and equipment suppliers, system designers, research organizations, and regulatory agencies. The data cover system design, fuel characteristics, operating history, and actual system performance. Also included is a unit-by-unit discussion of problems and solutions associated with the boilers, scrubbers, and FGD systems. The development status (operational, under construction, or in the planning stages), system supplier, process, waste disposal practice, and regulatory class are tabulated alphabetically by utility company. Simplified process flow diagrams of FGD systems, definitions, and a glossary of terms are attached to the report. Current data for domestic FGD systems show 126 systems in operation, 24 systems under construction, and 65 systems planned. The current FGD-controlled capacity in the United States is 49,574 MW.

37841 **(EPRI-CS/EA/EL—4480, pp 2.3-2.6) Pyroplasma detoxification of askarel fluids.** Barton, T.G. (Royal Military College of Canada, Kingston, Ontario). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A mobile unit has been undergoing a series of waste destruction demonstrations using organic fluids. This demonstration project has been jointly funded by the New York State Department of Environmental Conservation and the EPA Industrial Environmental Research Laboratory. The unit is a plasma based system which uses a Westinghouse high enthalpy plasma device to chemically atomize organic fluids. Following their atomization the elemental components are allowed to recombine to form fuel gas, acid gas and carbon. Preliminary results have shown that the system repeatedly achieved for CCl_4 a destructive efficiency greater than 99.9999%. Tests with askarel fluids are not complete. The success demonstrated by the unit with carbon tetrachloride indicates that askarel fluids should offer little additional technical challenge.

37842 **(EPRI-CS/EA/EL—4480, pp 2.7-2.10) Thermal treatment of PCBs and PCB-contaminated soils.** Boyd, J.W. (J.M. Huber Corp., Borger, TX). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

J.M. Huber Corporation has developed an Advanced Electric Reactor (AER) which is highly effective for decontaminating oils contaminated with PCBs and similar hazardous materials. The AER is a pyrolytic process which rapidly heats wastes to temperatures between 2200-2500 degrees C. A trial burn treating approximately 6400 kg of soil containing 3000 ug/g PCB was conducted. All TSCA requirements were exceeded including PCB destruction and removal efficiencies in the range of 99.99999%. The AER received EPA certification for destruction of PCBs in May 1984. Rotary kiln incineration (RKI) is presently considered to be an attractive technology for treatment of soils contaminated with hazardous wastes. The AER has inherent safety and performance advantages over RKI. 3 tables.

37843 **(EPRI-CS/EA/EL—4480, pp 2.11-2.14) PCB incinerator using molten glass both as heat source.** Penberthy, L. (Penberthy Electromelt Co., Seattle, WA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A diagram of a demonstration furnace is presented. It is a tunnel, 3 ft square by 22 feet long. The basin holds five tons of glass which is kept molten by heat from the burning PCBs, supplemented by electric heat as needed. PCB liquid is sprayed or poured on the hot glass surface. The organic portions vaporize and burn in air supplied from side gets. The organics burn to completion and inorganic residues, such as metal oxides or soil, fall on the glass and dissolve in it. The chlorine part of the PCB is converted to hydro-

gen chloride, which must be scrubbed out of the offgas. Several advantage of the system for the destruction of PCBs are given. 6 references, 4 figures.

37844 (EPRI-CS/EA/EL—4480, pp 3.1-3.4) **Non-sodium process for removal of PCBs from contaminated transformer oil.** Adams, G.P.; Peterson, R.L. (Niagara Mohawk Power Corp., Syracuse, NY). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Niagara Mohawk Power Corporation has developed a non-sodium process for decontamination of PCB-contaminated oil as an alternative to current methods. This patented process has been demonstrated at both laboratory and pilot plant scales, and a mobile prototype unit is currently in the start-up phase. The NMPC process allows recovery of the decontaminated transformer oil. It does not use metallic sodium, but rather a mixture of potassium hydroxide, glycol and sulfoxide. Field trials with PCB-contaminated oil will commence with receipt of EPA and NYSDEC permits. 4 references, 2 figures.

37845 (EPRI-CS/EA/EL—4480, pp 3.5-3.9) **Electrochemical process for decontaminating PCB-containing transformer coolants.** Massey, M.J.; Walsh, F.M. (Environmental Research & Technology, Inc., Concord, MA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Environmental Research and Technology, Inc., and Tracer Technologies, Inc. are developing an electrochemical technique for the controlled dehalogenation of a wide range of halogenated organics, including PCBs. Application of the technique to the in-situ decontamination of PCB-containing mineral oils and mineral oil transformers is discussed. The electrochemistry of the device is discussed, as are the results of initial performance tests. The schedule for commercialization of the device is outlined. 2 figures.

37846 (EPRI-CS/EA/EL—4480, pp 3.10-3.14) **Chemical destruction of polychlorinated biphenyl.** Chu, N.S.; Vick, S.C. (Union Carbide Corp., Tarrytown, NY). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

PCBs can be destroyed or detoxified by chemical means. The chemical destruction of PCBs contained in contaminated transformer oil has the advantage that it allows the recovery of the valuable transformer fluid. A chemical method which allows the destruction of PCBs in both dilute form such as PCB contaminated transformer fluids and in concentrated form such as askarel wastes is reported. The process is based on a nickel catalyzed zinc reduction of aromatic halides. Optimum conditions for PCB destruction are described, and reaction mechanisms are discussed. 12 references.

37847 (EPRI-CS/EA/EL—4480, pp 4.1-4.6) **Evaluation of a portable test kit for testing PCB contaminated soils and oils in the field.** Gauger, G.A.; Smith, G.C.; Sullivan, J.M. (McGraw-Edison Co., Franksville, WI). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The McGraw-Edison PCB field test kit was initially developed by the Centec Corp. to screen oil samples for PCBs. It was determined that the kit could be a fail safe screening tool provided that the interpretation was based on a more conservative calibration curve. To evaluate the usefulness of the kit for soil samples, over 27 different soil types were tested; spiked at 50 ppm, 250 ppm, and 1000 ppm with Aroclor 1260 to determine the effectiveness of the field extraction procedure by correlation of the kit results with gas chromatography. The effects of soil composition and moisture levels on kit performance are evaluated. Soils evaluated in a water saturated condition show a distinct reduction in extraction efficiency. The reduction for sandy soils is slight; it is more pronounced for both clay and organic type soils. Physical removal of the water by desiccant or mechanical techniques will enhance the capabilities of the kit in handling water saturated samples. 2 figures, 1 table.

37848 (EPRI-CS/EA/EL—4480, pp 4.7-4.14) **Clor-N-Oil test kit as a PCB screening tool.** Mills, D.W.; Rhoads, K. (Utah Power & Light Co., Salt Lake City). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The Clor-N-Oil test kits were developed by General Electric under contract from the Electric Power Research Institute. DEXSIL Chemical Corporation has exclusive license from EPRI to mass-produce the kits for industry-wide use. The kit does not measure PCBs but rather measures chlorine content of the oil. It is designed to read positive if the chlorine content of the oil. is greater than 21 ppm. The cutoff of 21 ppm is based on the chlorine content of the least halogenated Aroclor (1242). 50 ppm of Aroclor 1242 will contain at least 21 ppm of chlorine. The kit will only work on PCB-contaminated mineral oils and askarel fluids; it will not work on soils, waters or other material. The test kit was extensively evaluated. Results indicate that the test kit is an economical PCB screening tool, that the probability of false negatives with the test kit is not higher than the probability of a false negative by GC test methods, and that the Clor-N-Oil test kit is an analytically acceptable method for screening PCBs in distribution transformer oils. 2 references, 2 tables.

37849 (EPRI-CS/EA/EL—4480, pp 4.15-4.16) **Field testing of the S-Cubed gas chromatograph, PCBA-102.** Hein, J.C. (Brown and Caldwell, Emeryville, CA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Field instrumentation (PCBA-102) recently developed for EPRI by S-Cubed Corporation is intended to be highly portable and to not require an experienced analyst operator. A utility load program was set up to evaluate the instrument for accuracy and precision, convenience, technical expertise for operation, and the ability to handle PCBs in a variety of matrices. The performance of the instrument was subject to both instrument downtime and operator error. In general, adequate precision and accuracy was achieved with experienced gas chromatographers as operators. Downtime, imprecision and inaccuracy increased dramatically when inexperienced personnel were asked to perform instrument start-up and operation.

37850 (EPRI-EA—4543-CCM) **MYGRT: an IBM personal computer code for simulating solute migration in groundwater. User's manual.** Ungs, M.J.; Summers, K.V.; Gherini, S.A. (Tetra Tech, Inc., Lafayette, CA (USA)). May 1986. 76p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920325.

The overall objective of EPRI's Solid Waste Environmental Studies project is to develop and validate models to predict the release, transformation and migration of waste constituents from utility disposal sites. While such detailed models are being developed, participants in the First Technology Transfer Seminar suggested that methods for screening purposes be made available for personal computers. Two models (MYGRT1, a one-dimensional code, and MYGRT2, a two-dimensional code) were then adapted for the IBM PC (XT and AT with an 8087 math coprocessor). These codes are for screening purposes only, while the detailed geohydrochemical models are being developed. The codes are written in Fortran '66 and 8087-8088 Assembly languages. The codes are available in compiled/executable form on diskettes from the Electric Power Software Center. No compilers are necessary. The codes have been made interactive and user-friendly. Results are produced in less than a minute. Output can be printed in tabular or graphic format. The codes can be used to predict concentrations downgradient of a disposal site as a function of time or distance. The primary flow direction can be either horizontal or vertical. The processes included in the codes are advection, dispersion and retardation. This user's

manual describes the basis for the codes, the assumptions necessary, selected methods for estimating the required input data, and the solution techniques. Example problems for both the one- and two-dimensional codes are included.

37851 **(SVF—206) Evaluation of non-US coals emission performance with the distributed mixing burner. IEA-low NOsub(x)/Sosub(x) burner project stage II.** Abele, A.R.; Chen, S.L.; Greene, S.B.; Kwan, J.; Overmoe, B.J.; Payne, R. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). May 1985. 246p. NTIS (US Sales Only), PC A11/MF A01. File Number DE86752153.

This report describes the results of an experimental investigation, designed to evaluate the potential for combined NOsub(x) and SOsub(x) control with non-US coals and calcium based sorbents. Testing was condusted using a low-NOsub(x) Distributed Mixing Burner, and in a series of experimental furnaces ranging in scale from 21kW to 30MW thermal input. In total four coals were tested. Experimental data showed that NOsub(X) emissions were reduced by 40 to 70% with optimum staged combustion in the Distributed Mixing Burner. These data are comparable to the emissions reductions achieved on a range of coals of U.S. origin. Absolute values of NOsub(X) emission were found to depend on coal type, burner design, and on the furnace thermal environment (firing density and heat extraction). A preliminary correlation is proposed for the extrapolation of test data to full scale boilers. The reduction of SO_2 emission achieved was found to range between 20 and 50% at an injected calcium to coal sulfur mole ration of 2.0. This range is again comparable to data with U.S. coals and sorbents under similar operating conditions. SO_2 emission reduction potential depends mainly on the furnace thermal environment (temperature level-and resindence time), and the location (temperature) at which the sorbent is injected. In general, sorbent injection at lower furnace temperatures is more favorable for high SO_2 removal.

37852 **(DOE/EP/12067—H1-Vol.2-Pt.1) Utility FGD [flue gas desulfurization] survey, October-December 1984. Volume 2. Part 1 of 2. Design performance data for operating FGD systems.** Melia, M.T.; McKibben, R.S.; Jones, F.M. (PEI Associates, Inc., Cincinnati, OH (USA)). Jul 1985. Contract AC01-82EP12067. 679p. NTIS, PC A99/MF A01; 1; GPO Dep. File Number DE86012484.

The Utility FGD Survey report, which is generated by a computerized data base system, represents a survey of operational and planned domestic utility flue gas desulfurization (FGD) systems. The two volume set summarizes information contributed by the utility industry, system and equipment suppliers, system designers, research organizations, and regulatory agencies. The data cover system design, fuel characteristics, operating history, and actual system performance. Also included is a unit-by-unit discussion of problems and solutions associated with the boilers, scrubbers, and FGD systems. The development status (operational, under construction, or in the planning stages), system supplier, process, waste disposal practice, and regulatory class are tabulated alphabetically by utility company. Simplified process flow diagrams of FGD systems, definitions, and a glossary of terms are attached to the report. Current data for domestic FGD systems show 126 systems in operation, 24 systems under construction, and 65 systems planned. The current FGD-controlled capacity in the United States is 49,574 MW.

37853 **(DOE/EP/12067—H1-Vol.2-Pt.2) Utility FGD [flue gas desulfurization] survey, October-December 1984. Volume 2. Part 2 of 2. Design performance data for operating FGD systems.** Melia, M.T.; McKibben, R.S.; Jones, F.M. (PEI Associates, Inc., Cincinnati, OH (USA)). Jul 1985. Contract AC01-82EP12067. 674p. NTIS, PC A99/MF A01; 1; GPO Dep. File Number DE86012485.

The Utility FGD Survey report, which is generated by a computerized data base system, represents a survey of operational and planned domestic utility flue gas desulfurization (FGD) systems. The two volume set summarizes information contributed by the utility industry, system and equipment suppliers, system designers, research organizations, and regulatory agencies. The data cover system design, fuel characteristics, operating history, and actual system performance. Also included is a unit-by-unit discussion of problems and solutions associated with the boilers, scrubbers, and FGD systems. The development status (operational, under construction, or in the planning stages), system supplier, process, waste disposal practice, and regulatory class are tabulated alphabetically by utility company. Simplified process flow diagrams of FGD systems, definitions, and a glossary of terms are attached to the report. Current data for domestic FGD systems show 126 systems in operation, 24 systems under construction, and 65 systems planned. The current FGD-controlled capacity in the United States is 49,574 MW.

37854 **A utility's view of the Ebara E-Beam NO/sub x// SO/sub x/ removal process.** McKnight, R.A.; Antonetti, J.O.; Mattick, D. pp VI23-VI35 of Acid rain: Engineering solutions, regulatory aspects. Schwieger, R.G.; Elliot, T.C. New York, NY; Hemisphere Publishing (1985). (CONF-8503103—).

From 2. international conference on acid rain; Washington, DC, USA (26 Mar 1985).

This high technology approach should not be acclaimed as a way to make environmental controls profitable, but it has the potential to do a better job of control at less cost. The approach is not totally proven even if the pilot demonstration is fully successful, but we stand at the door of a full prototype demonstration system that is very revolutionary. Time, testing, and a great deal of money stand between the current state-of-the-art and crossing that threshold.

2003 Power Transmission And Distribution

37855 **Dynamic thermal line loading monitor.** Vakili, F.; Viles, M.R.; Reding, J.L.; Sherry, N.G. (Div. of System Operations, Bonneville Power Administration, P.O. Box 3621, Portland, OR 97208). *IEEE Transactions on Power Systems;* **PWRS-1:** No. 2, 62-66(May 1986).

Operating a reliable and safe power transmission system is the goal of BPA. In doing so, BPA usually does not attain maximum transmission capacity due to continuous loading thermal limits placed on the transmission system. Thermal limit being the highest temperature at which a line conductor can be operated without violating minimum ground clearance criteria. However, lines do not instantaneously attain their thermal limits. The time it takes a conductor to reach its thermal limit can be used to BPA's advantage. Instead of operating a transmission system to insure that a first contingency does not cause an overload condition, PBA can operate the system at higher current levels provided the conductor's thermal response allows adequate time for manual intervention.

21 NUCLEAR POWER PLANTS

37856 **(NUREG/BR—0051-Vol.7-No.6) Power reactor events, November-December 1985. Volume 7, No. 6.** Massaro, S.A. (ed.). (Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data). Jun 1986. 45p. NTIS, PC A03/MF A01 - GPO. File Number TI86901542.

"Power Reactor Events" is a bi-monthly newsletter that compiles operating experience information about commercial nuclear power plants. This includes summaries of noteworthy events and listings and/or abstracts of USNRC and other documents that discuss safety-related or possible generic issues. It is intended to feed back some of the lessons learned from operational experience to the various plant personnel, i.e., managers, licensed reactor operators, training coordinators, and support personnel.

2101 Power Reactors, Non-breeding, Light-water Moderated, Boiling Water Cooled

REFER ALSO TO CITATION(S) 37976, 38021, 38025, 38027, 38028, 38029, 38037, 38038, 38039, 38041, 38042, 38043, 38048, 38049, 38050, 38051, 38053, 38060

37857 (EPRI-NP—4552) Deaeration of makeup water for LWRs. Schlesinger, H.A.; Falk, K. (Gibbs and Hill, Inc., San Jose, CA (USA)). Jun 1986. 51p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920361.

Dissolved oxygen in pressurized water reactor condensate and steam generator feedwater promotes corrosion of secondary cycle piping, heat exchangers and steam generators. Since dissolved oxygen in make-up water is a direct source of secondary cycle oxygen ingress, make-up water system upgrading modifications for production and storage of deoxygenated water are described. Specifications and cost estimates for the addition of a vacuum deaerator and a sealed condensate storage tank to a 300 gpm existing or new make-up water system are given.

37858 (EPRI-NP—4602) BWR fuel rod performance evaluation program. Final report. Rowland, T.C. (General Electric Co., San Jose, CA (USA). Nuclear Fuel Engineering Dept.). May 1986. 103p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920340.

The joint EPRI/GE fuel performance program, RP510-1, involved thorough preirradiation characterization of fuel used in lead test assemblies, detailed surveillance of their operation, and interim site examinations of the assemblies during reactor outages. The program originally included four GE-5 lead test assemblies operating in the Peach Bottom-2 reactor. The program was later modified to include the pressurized fuel rod test assembly in the Peach Bottom-3 reactor (RP510-2). The program modification also included extending the operation of the Peach Bottom-2 and Peach Bottom-3 lead test assembly fuel beyond normal discharge exposures. Interim site examination results following the first four cycles of operation of the Peach Bottom-2 lead test assemblies up to 35 GWd/MT and the examination of the Peach Bottom-3 pressurized test assembly at 32 GWd/MT are presented in this report. Elements of the examinations included visual examination of the fuel bundles; individual fuel rod visual examinations, rod length measurements, ultrasonic and eddy current nondestructive testing, Zircaloy cladding oxide thickness measurements and fission gas measurements. Channel measurements were made on the PB-2 Lead Test Assemblies after each of the first three operating cycles. All of the bundles were found to be in good condition. Since the pressurized test assembly contained pressurized and nonpressurized fuel rods in symmetric positions, it was possible to make direct comparisons of the fission gas release from pairs of pressurized and nonpressurized fuel rods with identical power histories. With one exception, the release was less from the pressurized fuel rod of each pair. Fuel rod power histories were calculated using new physics methods for all of the fuel rods that were punctured for fission gas release measurements. 28 refs., 41 figs., 16 tabs.

37859 (NUREG/CR—3228-Vol.4) Structural integrity of water reactor pressure boundary components. Annual report, 1985. Volume 4. Loss, F.J. (ed.). (Materials Engineering Associates, Inc., Lanham, MD (USA)). Jun 1986. 205p. (MEA—2148-Vol.4). NTIS, PC A10/MF A01 - GPO. File Number TI86901518.

This propgram is being conducted for the NRC for the purpose of providing analytical and experimental methods and data that are necessary to ensure the structural safety and reliability of pressure boundary components in commercial light water reactor power systems. Emphasis is placed on characterization of material properties performance in a nuclear environment for the application to plant-life extension and mitigation of the consequences of postulated accident scenarios. Current work is organized into three major tasks: (1) fracture mechanics investigations; (2) environmentally-assisted crack growth in high temperature; primary reactor water; and (3) radiation sensitivity and postirradiation properties recovery. Research progress in these three tasks for 1985 is summariezed in this report.

37860 (SAND—86-1104C) FAID/SPAR field tests at KAHL. Final report. McKenzie, J.M.; Self, B.G.; Crawford, T.J.; Suber, L.A. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 4p. (CONF-860654—13). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012170.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

LWR fuel assemblies are convenient units for item accounting. Application of a fuel assembly seal which gives both integrity and a unique identity to the fuel assembly offers the potential of increased safeguards over present methods. This is particularly the case if the seal can be read at frequent intervals. The BWR Kahl reactor has been used to field evaluate FAID type ultrasonic seals. Twenty-four seals were applied to fresh fuel assemblies before their being placed in the reactor core. At convenient times when the reactor was shut down and the fuel moved to the spent fuel storage pool, the seal's identity and integrity were checked with a seal pattern reader (SPAR). After the reactor was decommissioned all seals were reidentified and their integrity checked. Five seals were removed from their fuel assemblies and embrittlement of the fracture link observed. Several seals were in the reactor core for three years.

37861 Volatile and gaseous fission-product source term evaluation during power ramping conditions in water reactor fuel using the mechanistic FASTGRASS computer code. Rest, J. (Argonne National Lab., IL, USA). *Res Mechanica;* **17**: No. 1, 71-87(1986).

As the noble gases play a major role in establishing the interconnection of escape routes from the interior to the exterior of nuclear reactor fuel, a realistic description of the release of volatile fission products (VFPs) must a priori include a realistic description of fission-gas release and swelling. The steady-state and transient gas release and swelling subroutine, FASTGRASS, has been modified to include a mechanistic description of behavior of VFPs (I, Cs, CsI, Cs_2MoO_4, and Cs_2UO_4). Phenomena modeled are the chemical reactions between the VFPs, VFP migration through the fuel, and VFP interaction with the noble gases. This paper will describe calculations performed with FASTGRASS to describe the release of noble gases, I, Cs, and CsI from LWR fuel during steady-state and power-ramping conditions. Key issues that are addressed in the analysis are the effects of (a) VFP chemistry, (b) various assumptions concerning mechanisms of VFP migration through solid UO_2, (c) fission-gas behavior, and (d) accident scenarios on the chemical form of iodine and the rate of iodine release from water-reactor fuel.

37862 Implementing a QA program for plant modifications. Palmer, D.R. (Niagara Mohawk Power Corp.). *Transactions of the American Nuclear Society;* **50**: 368-369(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The purpose of this paper is to describe the implementation of the quality assurance (QA) program within the modification process at Niagara Mohawk Power Corporation. The modification process includes design, procurement, installation, transition to operations, and closeout. Niagara Mohawk Power Corporation operates one nuclear power plant, a 610-MW General Electric (GE) boiling water reactor, and has another under construction, a 1080-MW GE reactor planned for commercial operation in October 1986. Niagara Mohawk has achieved a marked improvement in the implementation of its nuclear modifications. Modifications are now generally completed within budget and either on schedule or ahead of schedule. An example (the recirculation pipe replacement modification) is discussed and illustrates the increased QA attention to major modifications. This modification was a success from both Niagara Mohawk's point of view and also from our contractor's point of view. The implementation of the quality plan was a positive factor in the success of this modification.

37863 **EPRI nondestructive evaluation center: technology transfer to improve reliability.** Nemzek, T.A.; Schoenecke, P.L.; Wickliffe, G.W. (J.A. Jones Applied Research Co., Charlotte, NC). *Transactions of the American Nuclear Society;* 50: 370-371(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The development and improvement of nondestructive evaluation methods used by the electric utility industry for in-service inspection (ISI) is a priority program of the Electric Power Research Institute (EPRI). The institute established the EPRI Nondestructive Evaluation (NDE) Center in Charlotte, North Carolina. The NDE Center, completed in February 1981, is operated for EPRI by J.A. Jones Applied Research Company and is dedicated to the process of transferring EPRI inspection system research results to practical usage in power plant environments. The center employs the expertise and contains the necessary equipment and power plant hardware samples to effect a realistic evaluation of the technology from laboratory test to demonstration under simulated plant conditions. Inspection applications programs in progress at the NDE Center relate to pressurized water reactor (PWR) steam generator tubing, large-diameter BWR stainless steel piping, steam turbine rotors, and heavy components such as vessels, pump casings, and valves.

37864 **System engineering concept.** Hinkley, B.E. (Carolina Power & Light Co. Southport, NC). *Transactions of the American Nuclear Society;* 50: 375-376(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The system engineering concept is founded on the principles of ownership and responsibility. Basically, by developing a sense of ownership for an assigned system, the engieer takes personal pride in that system's performance and assumes the responsibility to ensure that his/her assigned system is the best that it can be. The purpose of this paper is to describe the basic concepts behind the system engineer approach and to provide some results from an operating boiling water reactor (Carolina Power Light's Brunswick plant) using this concept.

37865 **Relocation of resources from the general office to the Palisades site.** Firlit, J.F.; Dobbs, J.H.; Elbert, P.A. (Consumers Power, Palisades, NY). *Transactions of the American Nuclear Society;* 50: 377-378(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper addresses the circumstances surrounding the decision to reorganize the Nuclear Operations Department at Consumers Power, subsequent planning to accomplish the reorganization, and the implementation associated with the reorganization of resources from corporate headquarters to operating plant sites. The process of reorganization consisted of the strategic decision of what to reorganize, the factors considered in implementing the reorganization, as well as the advantages and disadvantages of the planned changes.

37866 **Power uprate program for the Duane Arnold Energy Center.** Browning, R.A. (Iowa Electric Light & Power, Cedar Rapids). *Transactions of the American Nuclear Society;* 50: 386-387(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

On March 27, 1985, the US Nuclear Regulatory Commission (NRC) granted an application to permit the Duane Arnold Energy Center (DAEC) to increase its maximum allowable generating capacity by ~4%. With the issuance of Amendment No. 115 to Operating License DPR-49, the DAEC became the first operating boiling water reactor 4 (BWR/4) to be allowed to uprate its allowable output. The uprating modifications and the licensing procedure are discussed.

37867 **Application of design margins for BWR power update.** Rogers, A.E.; Stancavage, P.P. (General Electric, San Jose, CA). *Transactions of the American Nuclear Society;* 50: 387(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper presents the bases for increasing the power level of a boiling water reactor (BWR) and explains broadly how power uprate is achieved. BWR plants have margins to increase power level. The first stage in power uprate is a feasibility evaluation, which establishes the target power level and identifies the detailed analyses, tests, and modifications necessary. Implementation involves carrying out the identified steps and securing regulatory approval.

37868 **BWR plant outage experience.** Stuart, E.F.; Williams, A.G. (General Electric, San Jose, CA). *Transactions of the American Nuclear Society;* 50: 400(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Data on outage history show that on the average, a boiling water reactor (BWR) fleet member can expect to start life with about a 90-day outage at the first outage. The data also show how the average outage duration varies with the number of outages conducted. The number of plants included in the data base ranges from 28 plants with a first outage to 4 plants with a 10th outage. One immediate conclusion from a plot of the data is that experience does not apparently lead to improvement. It should also be noted that the data include multi-unit sites where common crews are used.

37869 **Managing BWR plant life extension.** Ianni, P.W.; Kiss, E. (General Electric, San Jose, CA). *Transactions of the American Nuclear Society;* 50: 414-415(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Recent studies have confirmed that extending the useful life of a large nuclear plant can be justified with very high cost benefit ratio. In turn, experience with large power plant systems and equipment has shown that a well-integrated and -managed plan is essential in order to achieve potential economic benefits. Consequently, General Electric's efforts have been directed at establishing a life extension plan that considers alternative options and cost-effective steps that can be taken in early life, those appropriate during middle life, and those required in late life. This paper briefly describes an approach designed to provide the plant owner a maximum of flexibility in developing a life extension plan.

37870 **Nuclear plant life extension and critical components.** Mentink, H.; Neils, G.H.; Carey, J.J. *Transactions of the American Nuclear Society;* 50: 417-419(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Nuclear stations can be better utilized by alternatives other than decommissioning after 40 yr. Plant life extension (PLEX) beyond 40 yr of life delays decommissioning costs, loss of assets, and the financial burden of constructing and licensing new facilities. In early 1984, Northern States Power (NSP) commissioned an in-depth study of the Monticello boiling water reactor plant to determine technical and economic feasibility of plant life extension. This pilot plant study was subsequently cosponsored by the Electric Power Research Institute and the US Department of Energy with the objective of implementing the PLEX program applying for a license amendment. This paper presents a brief synopsis of the program approach. Recognizing the potential licensing difficulties to extend the plant life by only 10 yr, the necessary technical bases to justify extended life must be developed early in the design plant life. The Monticello plant specific life extension program includes criteria to determine the critical plant components, component topical reports, and a plant life cycle management chart.

37871 **Leibstadt: a 950-MW(e) BWR/6 Mark-III in commercial operation.** Fischer, P.U. *Transactions of the American Nuclear Society;* 50: 484-485(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

It may be somewhat premature to report on a plant that started up in 1984 as the first of General Electric's (GE's) BWR/6 Mark-III plants in the Western Hemisphere and commenced commercial operation on December 15, 1984. The theme of the session certainly applies to the overall Swiss nuclear program and the search for excellence has been our ambition out of economic and energy supply necessities. Leibstadt came on line just in time to cover the needs of the Swiss consumers during the winter of 84/85. It has provided reliable service from the outset and operated during the extreme European cold wave in January 1985 without interruption. In 1985 the plant is expected to cover ~15% of the electricity needs of Switzerland. The encouraging start of commercial operation gives hope that with time Leibstadt will be able to approach the capacity factors of the other four Swiss nuclear power stations, which in 1984 were between 88.4 and 90.3%.

37872 **Achievements in nuclear energy in the Federal Republic of Germany.** Messer, K.P. *Transactions of the American Nuclear Society;* **50**: 489(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

At present, nuclear power plants are supplying ~30% of the electric energy generated in the Federal Republic of Germany (FRG). There are 19 power reactors in operation with a total installed capacity of ~17 GW (gross). In 1984 their average capacity factor was 82.6%. For many years, German power reactors have ranked rather high in the world list of nuclear power plant performance. There are many reasons for this, which may be grouped into two fields: 1) design, manufacture, and construction, and 2) operation management. There is an area other than nuclear power plant technology and management where German utilities and nuclear industry have achieved a good performance: the nuclear fuel cycle. Today, the German uranium companies are producing more natural uranium than is needed for our nuclear power plants. Major progress in uranium enrichment technology was achieved by developing the URENCO gas centrifuge with essential German participation. The high availability and good economics of German nuclear power plants are also due to an advanced fuel assembly design. As to the back-end of the fuel cycle, the political situation has not been favorable for a timely realization of the installations needed. However, considerable progress has been made in developing an advanced reprocessing technology.

37873 **Brunswick scram reduction program.** Jones, M.A. (Carolina Power & Light, Southport, NC). *Transactions of the American Nuclear Society;* **50**: 494-496(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The purpose of this paper is to describe the scram reduction methods being used at the Brunswick plant. The fundamentals of a good scram reduction program are a well-designed and -constructed plant (usually of simple design), an experienced plant staff, and a balance of good procedures and training. The Brunswick plant initiated its current scram reduction program over 1.5 yr ago. The scope has broadened during this period and increased emphasis on the Institute of Nuclear Power Operations, the US Nuclear Regulatory Commission, and industry groups have served to step up the pace. The Brunswick scram reduction program is an organized and systematic method of determining where available resources will have the greatest impact (payback) on scram reduction. The method used is described. Although many results of this program are long range, benefits have already been seen in the implementation of the high-benefit, low-cost fixes for scrams. As of June 1985, the Brunswick units had had only one scram during 1985.

37874 **Viable scram reduction program: its cost and benefits.** Parkyn, J.D. (Dairyland Power Cooperative). *Transactions of the American Nuclear Society;* **50**: 499-500(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The LaCrosse Boiling Water Reactor (LACBWR) is a 50-MW Allis-Chalmers unit designed and built in the early 1960's. It is a two-loop unit and all but one single function (power range scram) of its scram logic is built on a one-out-of-two logic. The history of scrams at the LaCrosse plant indicates a significant reduction. The statistical history at LaCrosse over the last 5 yr has been analyzed. Evaluation of the causes of scrams led to development of a comprehensive program for transient reduction by license amendment, surveillance tests frequency change, hardware modification, and procedural change.

37875 **Reducing the frequency of scrams in US nuclear power plants.** Visner, S. *Transactions of the American Nuclear Society;* **50**: 503-504(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The industry has made considerable progress in reducing the number of unplanned scrams each year and is setting challenging goals for further reductions. To identify opportunities for further improvements, causes of scrams were analyzed and plant operations and design features were noted that reduce these causes. The data show that problems in the feedwater, condensate, and turbine-generator systems were the most frequent causes of scrams. Electrical and reactor protection system problems were also significant causes. Significant plant-to-plant differences in scram rates were identified for plants of similar design, age, and other factors. Institute of Nuclear Power Operations teams visited domestic plants with low scram histories. Specific operations, maintenance, training, and other practices were reviewed as well as design features. Over 100 design changes, operational, training, testing, and maintenance techniques were compiled. Design and modifications were mainly to improve reliability of feedwater, turbine-generator, and electrical systems.

37876 **Development of a loose parts detection and diagnostic system.** Izumi, S.; Michiguchi, Y.; Senoh, M.; Nakano, Y. (Hitachi ERL, Ibaraki, Japan). *Transactions of the American Nuclear Society;* **50**: 524-525(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The capability to locate impact sound sources on the pressure vessels of light water reactors is an important function for loose parts monitoring systems. Such inhomogeneous systems, however, have sound wave speeds and/or sound attenuation powers that are not constant and sound propagation paths that are not uniformly determined. These present problems in accurate sound location. The authors constructed a microcomputer-based loose parts detection and diagnostic system and incorporated a new location algorithm into the program. This location method can overcome the above problems by employing reference impact sound sources for which positions are previously known. Confirmation tests using a one-third-scale model of a boiling water reactor pressure vessel were carried out.

37877 **Water chemistry experience in current low-crud boiling water reactors.** Otoha, K.; Yoshikawa, S.; Suzuki, Y.; Ohsumi, K.; Miki, M.; Asakura, Y.; Uchida, S. (Tokyo Electric Power Co., Japan). *Transactions of the American Nuclear Society;* **50**: 525-526(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The first Japanese standard boiling water reactor (BWR), Unit 2 of Fukushima-Daini nuclear power plant [2F-2; 1100 MW(e)], operated commercially for 10,320 effective full-power hours for its first fuel cycle. During the first fuel cycle period, water chemistry data were collected and evaluated, which suggested a low shutdown dose rate around the primary systems. The estimation was confirmed by the measured dose rate after the scheduled shutdown in January 1985.

37878 **Evaluation of ^{60}Co behavior of an iron crud suppressed BWR.** Uchida, S.; Asakura, Y.; Nagase, M.; Ohsumi, K.; Miki, M. (Hitachi ERL, Ibaraki, Japan). *Transactions of the American Nuclear Society;* **50**: 527(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

In the first Japanese standard boiling water reactor, the 1100-MW(e) Fukushima-Daini Nuclear Power Station Unit 2, iron crud concentrations in the feedwater and the reactor water are

being suppressed to much less than the target value of 1 ppb, which causes low ^{60}Co radioactivity in the reactor water. However, the nickel concentration in the reactor water is much higher, which causes high ^{58}Co in the reactor water.

37879 **Chemical composition of crud deposits on BWR fuel surfaces.** Niki, Y.; Matsushima, Y.; Yonezawa, K.; Uchida, S.; Asakura, Y.; Ohsumi, K. (Chugoku Electric Power Co., Hiroshima, Japan). *Transactions of the American Nuclear Society;* 50: 527-529(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

In boiling water reactor primary cooling systems, more than 90% of the crud carried through the feedwater line deposits on the fuel surface. The deposited crud is activated by neutron irradiation in the core to become the major source of ^{60}Co. While mechanisms of crud deposition have been proposed, only limited measured data on the fuel deposits have been reported. In this report, analytical results of the fuel deposits on the spent fuel of Shimane nuclear power station are presented to aid in the understanding of corrosion product behavior around the fuel and refinement of the deposition mechanism.

37880 **QPANDA: an advanced nodal method for LWR analyses.** Smith, K.S.; Ver Planck, D.M.; Edenius, M. (Studsvik USA). *Transactions of the American Nuclear Society;* 50: 532-533(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The purpose of this paper is to introduce a new nodal diffusion method that allows full use of sophisticated homogenization techniques and has computational and storage requirements that are nearly the same as the less sophisticated traditional nodal methods. A new solution algorithm has been incorporated into a three-dimensional two-group diffusion code called QPANDA (Quartic Polynomial Analytic Nonlinear Diffusion Accelerated), which has the following characteristics: 1. The total storage requirements are 13 three-dimensional arrays. 2. Fission source iteration is accelerated by Wielandts' fractional iteration (eigenvalue shifting) and asymptotic source extrapolation. 3. Flux iteration is accelerated by a checkerboard cyclic Chebyshev semi-iterative technique. 4. The boundary conditions include: zero flux, zero net current, albedos, periodicity, rotational, or diagonal symmetry. 5. Discontinuity factors are allowed for all nodal surfaces and both energy groups. The amount of computational effort required to evaluate coupling coefficients is approximately four times less than was required in the nonlinear QUANDRY formulation.

37881 **Multidimensional nodal analysis of boiling water reactor stability.** Huang, S.F.; Becker, M. (Rensselaer Polytechnic Institute, Troy, NY). *Transactions of the American Nuclear Society;* 50: 539-540(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

A full three-dimensional space-dependent kinetics analysis of boiling water reactors has shown that spatial coupling has a significant effect on the prediction of stability margins. The full three-dimensional calculation was made possible and economical by using the sparse matrix technique and by a channel grouping procedure, particularly in loop analysis. The channel grouping procedure considerably reduces the magnitude of computing time and storage without loss of accuracy.

37882 **Nonlinear dynamics and stability of boiling water reactors: qualitative and quantitative analyses.** March-Leuba, J.; Cacuci, D.G.; Perez, R.B. (Oak Ridge National Lab., TN). *Transactions of the American Nuclear Society;* 50: 543(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

A phenomenological model has been developed to simulate the qualitative behavior of boiling water reactors (BWRs) in the nonlinear regime under deterministic and stochastic excitations. After the linear stability threshold is crossed, limit cycle oscillations appear due to interactions between two unstable equilibrium points and the phase-space trajectories. This limit cycle becomes unstable when the feedback gain exceeds a certain critical value. Subsequent limit cycle instabilities produce a cascade of period-doubling bifurcations that leads to a periodic pulsed behavior. Under stochastic excitations, BWRs exhibit a single characteristic resonance, at ~0.5 Hz, in the linear regime. By contrast, this work shows that harmonics of this characteristic frequency appear in the nonlinear regime. Furthermore, this work also demonstrates that amplitudes of the limit cycle oscillations do not depend on the variance of the stochastic excitation and remain bounded at all times. A physical model of nonlinear BWR dynamics has also been developed and employed to calculate the amplitude of limit cycle oscillations and their effects on fuel integrity over a wide range of operating conditions in the Vermont Yankee reactor. These calculations have confirmed that, beyond the threshold for linear stability, the reactor's state variable undergo limit cycle oscillations.

37883 **Heterogeneity effects on the detector field of view in the radial direction in BWRs.** Antonopoulos-Domis, M.; Skarpeta, K. (Aristotelian Univ., Greece). *Transactions of the American Nuclear Society;* 50: 548-549(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Flow patterns in boiling water reactors (BWRs) may be identified from neutron noise signals excited by void fluctuations propagating along the fuel bundles surrounding the bypass region in which the neutron detectors are placed. The system's relaxation lengths, thus the detector's field-of-view, depend on the heterogeneity of the core. In all theoretical works, heterogeneity is accounted for with the Feinberg-Galanin method. In the present work, the authors use an explicitly heterogeneous one-dimensional model in the radial direction to investigate heterogeneity effects on the detector field-of-view and in particular on the total relaxation length, since it is the total width of the detector field-of-view that is important, due to attenuation (local) or multiplication (global). In the model, the core is composed of fuel plates of finite width h/sub f/ and of coolant channels of width h/sub m/. Despite its obvious drawbacks, the one neutron energy model used here enables the qualitative investigation of the effect of heterogeneity. The relevant equations for the Green's function $G(x,x_0,jw)$ are solved numerically with second-order finite differences; G is very sensitive to deviations from criticality, which is ascertained via appropriate adjustment of the factor n, the number of neutrons produced per thermal neutron absorbed in the fuel.

37884 **Normalization of nodal models for reactor core analysis.** Simonson, S.C. (UAI, Sunnyvale, CA). *Transactions of the American Nuclear Society;* 50: 551(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

A software package, NORMA, has been developed for calculating nodal model leakage and reactivity correction factors based on quarter-core fine-mesh diffusion theory calculations. The NORMA package replaces a time-consuming and often inexact manual task with accurate and efficient calculational methods that give reproducible results. This permits the accuracy available in the PDQ model to be brought over into the nodal model, thus benefiting the application of the nodal model in operations support and reload design.

37885 **Gadolinia fuel performance in BWRs.** Bailey, W.E.; Crowther, R.L. (GE, San Jose, CA). *Transactions of the American Nuclear Society;* 50: 552-553(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Gadolinia has the unique property of having a high neutron absorption cross section coupled with a burnup rate that can approximately match the uranium 235 depletion. These qualities and others make gadolinia an ideal burnable absorber, and it has been used in all General Electric-designed boiling water reactors. Fabrication corrosion properties, and performance of gadolinia-containing fuel elements are discussed. Development of a reliable and efficient set of local and global gadolinia-urania design methods has been an arduous process that has taken ~15 years to accomplish.

37886 MICBURN-CASMO analysis of fuel with advanced gadolinia design. Edenius, M. (Studsvik USA). *Transactions of the American Nuclear Society;* **50**: 553-555(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Today, the calculation of fuel containing gadolinia as a burnable absorber is routine for both boiling water reactors (BWRs) and pressurized water reactors (PWRs). Over 10 yr of experience with gadolinium in BWRs and several years of gadolinium usage in PWRs have demonstrated the adequacy of the MICBURN-CASMO model. The physics model in the original MICBURN version has been found to be accurate and is still applicable. However, new features for advanced designs like annular gadolinium pellets and gray gadolinium rods have been developed based on the original theoretical model, and the application of few-group cross sections in core calculations have been significantly improved by the usage of flux discontinuity factors in the nodal codes.

37887 Importance of momentum dynamics in BWR neutronic stability: experimental evidence. March-Leuba, J.; Otaduy, P.J. (Univ. of Tennessee, Knoxville). *Transactions of the American Nuclear Society;* **50**: 563-564(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Momentum dynamics affect the boiling water reactor (BWR) neutronic stability by coupling steam void perturbations and core-inlet coolant flow. Computer simulations have shown that proper modeling of the recirculation loop, which shares the upper and lower plena pressures with the reactor core, is essential for accurate stability calculations. The purpose of the present work is to show experimental evidence, obtained from a recent series of stability tests performed at the Browns Ferry-1 BWR, demonstrating the important role of momentum dynamics in BWR neutronic stability.

37888 PWR-PSMS benchmarking using ex-core information from the Summer-1 plant. Peng, C.M.; Ipakchi, A.; Kim, J.H. (System Control, Inc., Arlington, VA). *Transactions of the American Nuclear Society;* **50**: 564-565(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Ex-core detectors are used in pressurized water reactors (PWRs) to provide continuous information on the core-average power distribution. The detector's response depends on power level as well as core power distribution, and the signals from individual detectors are used in measuring gross power shapes represented by axial offset (AO) and radial quadrant tilt. In full-power operation, those detectors provide information for power distribution monitoring, control, and protection systems. With the power shape monitoring system (PSMS), one can perform an on-line adjustment of the nodal code to match the detector readings partially and to statistically characterize the remaining errors. The AO was used as the phase shift indicator. It obtains the measured AO from ex-core readings and then adjusts the model to make the predicted AO match the measured AO each time the on-line three-dimensional nodal calculations are performed. The average axial error of the power distribution is an important indicator of overall model performance. The ex-core readings can be used for real-time adaptation of the overall axial power shape on a continuous basis. Once the overall core average axial power shape is predicted accurately, the detailed power distribution will be satisfactory. The purpose of this paper is to present the benchmark results of PWR-PSMS using ex-core detector data from the Summer-1 plant.

37889 Operating experience with axially two-zoned initial fuel core. Shimoshige, T.; Yamashita, J.; Tabata, N. (Hitachi, Ibaraki, Japan). *Transactions of the American Nuclear Society;* **50**: 565-567(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Axially two-zoned fuel with an optimized gadolinia design was applied to the initial core of unit 2 of Fukushima-Daini nuclear power station (2F-2), an 1100-MW(e) boiling water reactor. The flattened axial power distribution was successfully measured and excellent operational performance was obtained. The initial fuel in 2F-2 has about 0.2 wt% higher enrichment in the upper half than in the lower half of the fuel elements. The axially two-zoned fuel rods constitute ~40% of the total fuel rods. The gadolinia content of this fuel was optimized to maintain constant excess reactivity over almost the entire operating cycle. Through the operation of the 2F-2 first cycle with the fully loaded axially two-zoned fuel in the core, the following results were obtained: 1. The TIP-measured axial power distribution was flat all over the core and throughout the cycle, and the maximum linear heat generation rate was decreased to 80% of that in the conventional initial core. The decreased maximum linear heat generation rate reduced the power loss due to control rod pattern exchanges and adjustments. 2. The frequency of control rod pattern exchange and adjustment was approximately one-third of that in the conventional initial core, and operation was simplified. 3. The capacity factor achieved during operation was 99% due to the expected performance of the axially two-zoned fuel.

37890 Experience with single control rod pattern operation in axially two-zoned fuel cores. Nishimura, A.; Yokomi, M.; Yamada, A. (Hitachi, Ibaraki, Japan). *Transactions of the American Nuclear Society;* **50**: 567-568(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

An improved core with axially two-zoned fuel has been developed and applied to the commercial power plant described to improve the capacity factor and simplify operation. The sixth cycle of unit 4 of Fukushima-Daiichi nuclear power station (1F-4), a 784-MW(e) BWR/4 was operated as a single unit without any exchange of control rod pattern.

37891 Computational methods for fracture analysis of heavy-section steel technology (HSST) pressure vessel experiments. Bass, B.R.; Bryan, R.H.; Bryson, J.W.; Merkle, J.G. (Martin Marietta Energy Systems, Oak Ridge, TN, USA; Oak Ridge National Lab., TN, USA). *Nuclear Engineering and Design;* **86**: No. 1, 93-109(Apr 1985). (CONF-8310143—). Contract AC05-84OR21400.

From 11. NRC water reactor safety research information meeting; Gaithersburg, MD, USA (14 Oct 1983).

This paper summarizes the capabilities and applications of the general-purpose and special-purpose computer programs that have been developed at ORNL for use in fracture mechanics analyses of HSST pressure vessel experiments. Emphasis is placed on the OCA/USA code, which is designed for analysis of pressurized-thermal-shock (PTS) conditions, and on the ORMGEN/ADINA/ORVIRT system which is used for more general analysis. Fundamental features of these programs are discussed, along wih applications to pressure vessel experiments.

37892 Analysis of seismic sloshing of reactor tanks considering submerged components and seismic isolation. Ma, D.C.; Chang, Y.W. (Reactor Analysis and Safety Div., Argonne National Lab., Argonne, Illinois). pp 139-147 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-7. Fluid structure dynamics. Ma, D.C.; Moody, F.J. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—).

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

A study of the seismic sloshing response of a large pool-type reactor tank with several deck-mounted components is presented. The main objective of the study is to investigate the effects of internal components on the sloshing response and to determine the sloshing loads on the components. The study shows that the presence of internal components can significantly change the dynamic characteristics of the sloshing motion. The sloshing frequencies of a tank with internal components are considerably higher than those of a tank without internals. The higher sloshing frequencies reduce the sloshing wave height on the free surface but the dynamic pressures of the fluid are increased. The effects of seismic isolation on sloshing response are also presented.

37893 SAFT-UT field experience. Doctor, S.R.; Crawford, S.L.; Hall, T.E. (Pacific Northwest Lab., Richland, Washington). pp 203-211 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-1. Residual-life assessment, nondestructive examination, and nuclear heat exchanger materials. Jaske, C.E. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—).

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

This paper reports on a three-year program at the Battelle, Pacific Northwest Laboratory to transfer the synthetic aperture focusing technique (SAFT) technology that was developed at the University of Michigan into the field. A brief overview is given of the program and the field system is described. The main portion of the paper is devoted to the experience of using the SAFT system in a third-party role to aid in resolving inspection inconsistencies between several different UT inservice inspections results for intergranular stress corrosion cracks (IGSCC) in boiling water reactor (BWR) piping. A new method of scanning using a modified tandem technique (called TSAFT) was also developed and successfully employed in the field. The SAFT images made cracks easy to identify and the TSAFT data were easy to interpret for depth sizing. However, the most significant fact about the system is that it did work very well under field conditions even though a number of improvements were identified as a result of each field trip. These improvements are discussed in the paper.

37894 Predicted irradiation effects on alloy aging kinetics. Simonen, E.P. (Pacific Northwest Lab., Richland, WA). pp 157-164 of Proceedings of the international conference on nuclear power plant aging, availability factor and reliability analysis. Goel, V.S. Metals Park, OH; American Society of Metals (1985). (CONF-850713—). Contract AC06-76RL01830.

From International conference on nuclear power plant aging, availability factor and reliability analysis; San Diego, CA, USA (7 Jul 1985).

Irradiation was predicted to have significant influences on low temperature aging kinetics drying low dose irradiation of ferritic steel. Fine scale precipitate microstructures were predicted. Nucleation and growth kinetics controlled by irradiation enhanced diffusion of solute over short distances were shown to be important. Irradiation effects on the production and recovery of dislocation line length were also evaluated. Interstitial loop growth dominated network recovery processes for Light Water Reactor (LWR) irradiation conditions and the dislocation processes were not sensitive to dose rate and temperature. At low dose rates, fine scale irradiation damage (depleted zones) was susceptible to calculated annealing and therefore, dose rate effects were predicted.

37895 CREDO data analysis: A comparison of liquid metal and water valve reliabilities. Painter, S.L.; Knee, H.E. (Oak Ridge National Lab., Oak Ridge, TN). pp 523-526 of Proceedings of the international conference on nuclear power plant aging, availability factor and reliability analysis. Goel, V.S. Metals Park, OH; American Society of Metals (1985). (CONF-850713—). Contract AC05-84OR21400.

From International conference on nuclear power plant aging, availability factor and reliability analysis; San Diego, CA, USA (7 Jul 1985).

In this paper, data from the Centralized Reliability Data Organization (CREDO) are used to calculate failure rates and unscheduled maintenance frequencies for liquid metal valves. These failure rates and unscheduled maintenance frequencies are then compared to those calculated for valves from light water reactors. The liquid metal valves showed, in general, failure rates and unscheduled maintenance frequencies that are significantly lower than those of water valves (sometimes as much as an order of magnitude). Two possible reasons for the trend of lower failure rates and maintenance frequencies for liquid metal valves are then discussed.

2102 Power Reactors, Non-breeding, Light-water Moderated, Non-boiling Water Cooled

REFER ALSO TO CITATION(S) 37857, 37859, 37861, 37863, 37865, 37872, 37875, 37876, 37880, 37886, 37891, 37892, 37894, 37895, 37976, 38022, 38023, 38026, 38029, 38039, 38041, 38042, 38044, 38045, 38046, 38050, 38051, 38053, 38054, 38055, 38056

37896 (DOE/SSDP—0003) Shippingport station decommissioning project overview. Usher, J.M. (UNC Nuclear Industries, Shippingport, PA (USA). Shippingport Decommissioning Project Office). 1986. Contract AC06-84RL10421;AC06-76RL01857. 6p. (CONF-860724—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011893.

From ASME/ANS bi-annual nuclear power conference: safe and reliable nuclear power plants; Philadelphia, PA, USA (20 Jul 1986).

The US Department of Energy (DOE) is in the process of decommissioning the Shippingport Atomic Power Station (SAPS), the first commercial-sized nuclear power plant in the United States to undergo complete dismantlement. SAPS is located near Pittsburgh, Pennsylvania, on approximately seven acres of land owned by Duquesne Light Company (DLC), and leased to the US Department of Energy. The Station consists of a 275' by 60' Fuel Handling Building containing the Reactor Containment Chamber, the Service Building, the Turbine Building, the Radioactive Waste Processing Building, the Administration Building, and other smaller support buildings. The Station has four coolant loops; most of the containment structures are located below grade. Shippingport Station was shutdown in October, 1982. Defueling operations began in 1983 and were completed by September 1984. At that time, responsibility for the plant was transferred from DOE Office of Assistant Secretary for Naval Reactors (NE-60) to DOE Office of Terminal Waste Disposal and Remedial Action (NE-20) and then to DOE Richland Operations Office (RL). Also at that time, responsibility for the operation/decommissioning of the station systems passed from DLC to General Electric Company (GE). A caretaker and site preparation period lasted from September, 1984 to September, 1985, at which time decommissioning activities started. The decommissioning period is scheduled as September, 1985 through April, 1990. Project total estimated cost is $98.3 million.

37897 (DOE/SSDP—0004) Shippingport station decommissioning project start of physical decommissioning. Crimi, F.P. (General Electric Co., Shippingport, PA (USA). Nuclear Energy Business Operations). 1986. Contract AC06-84RL10421;AC06-76RL01857. 15p. (CONF-860724—4). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011892.

From ASME/ANS bi-annual nuclear power conference: safe and reliable nuclear power plants; Philadelphia, PA, USA (20 Jul 1986).

The Shippingport Atomic Power Station (SAPS) consists of the nuclear steam supply system and associated radioactive waste processing systems, which are owned by the United States Department of Energy (DOE), and the turbine-generator and balance of plant, which is owned by the Duquesne Light Company. The station is located at Shippingport, Pennsylvania on seven acres of land leased by DOE from Duquesne Light Company. The Shippingport Station Decommissioning Project (SSDP) is being performed under contract to the DOE by the General Electric Company and its integrated subcontractor, Morrison-Knudsen Company, as the Decommissioning Operations Contractor (DOC). This paper describes the current status of the physical decommissioning work, which started September 1985. The preparations required to start a major decommissioning work effort in a safe and cost effective manner are discussed including the development of integrated detailed schedules, manpower and cost estimates, and implementation of a cost/schedule control system. The detailed plan required to ensure that people, property, and procedures are ready in sufficient time to support the start of physical decommissioning is also discussed. The total estimated cost of the Shippingport Station Decommissioning Project should be $98.3 M, with the Project scheduled for completion in April 1990. As the decommissioning of the first commercial-

scale nuclear power plant, the Shippingport Project is expected to set the standard for safe, cost-effective demolition of nuclear plants.

37898 **(DOE/SSDP—0005) Shippingport station decommissioning project technology transfer program.** Pasquini, L.A. (UNC Nuclear Industries, Shippingport, PA (USA). Shippingport Decommissioning Project Office). 1986. Contract AC06-84RL10421;AC06-76RL01857. 5p. (CONF-860724—7). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011891.

From ASME/ANS bi-annual nuclear power conference: safe and reliable nuclear power plants; Philadelphia, PA, USA (20 Jul 1986).

The purpose of the Shippingport Station Decommissioning Project (SSDP) is to place the Shippingport Atomic Power Station in a long-term radiologically safe condition following defueling of the reactor, to perform decommissioning in such a manner as to demonstrate to the nuclear industry the application of decommissioning procedures to a large scale nuclear power plant, and to provide useful planning data for future decommissioning projects. This paper describes the Technology Transfer Program for collecting and archiving the decommissioning data base and its availability to the nuclear industry.

37899 **(DOE/SSDP—0006) Release criteria for decommissioning of the Shippingport Atomic Power Station.** Eger, K.J.; Gardner, D.L.; Giordano, R.J. (General Electric Co., Shippingport, PA (USA). Nuclear Energy Business Operations). 1986. Contract AC06-84RL10421;AC06-76RL01857. 7p. (CONF-860724—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011890.

From ASME/ANS bi-annual nuclear power conference: safe and reliable nuclear power plants; Philadelphia, PA, USA (20 Jul 1986).

The United States Department of Energy (DOE) has established guidelines for allowable levels of residual radioactivity at remote sites in the Surplus Facilities Management Program (SFMP). These guidelines specify that doses to the public from this residual radioactivity must not exceed 500 mrem/year (for up to five years) or 100 mrem/year (for a lifetime), regardless of the use of the land. The guidelines also specify that exposures be further limited, depending on ALARA considerations. The decommissioning of the Shippingport Atomic Power Station, done under the auspices of SFMP, is being performed in accordance with these guidelines. It follows that, at the conclusion of the project, the concentrations of residual radioactivity, identified both by isotope and location (x,y,z), must be low enough so that the guidelines (500,100) are not exceeded. Furthermore, the concentrations must be low enough so that additional action which might be taken to reduce them cannot cost effectively decrease the dose to the public. A cost-benefit analysis, based on actual conditions at Shippingport, is being prepared to identify these "low-enough" concentrations. Once identified, these concentrations will comprise the release criteria for the site. The analysis will be developed by (1) performing an initial site characterization, (2) employing pathways analyses to compute the dose to a future occupant, (3) costing of proposed site modifications, and (4) repeating a pathways analysis based on each "as-modified" location on the site. The result will be a paired set of data relating the cost of modification to the reduction in the dose to the future occupant.

37900 **(DOE/SSDP—0007) Shippingport Station Decommissioning Project (SSDP): configuration control system and project activity controls.** Mullee, G.R. (General Electric Co., Shippingport, PA (USA). Nuclear Energy Business Operations). 1986. Contract AC06-84RL10421;AC06-76RL01857. 5p. (CONF-860724—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011760.

From ASME/ANS bi-annual nuclear power conference: safe and reliable nuclear power plants; Philadelphia, PA, USA (20 Jul 1986).

The SSDP has been using a Configuration Control system as a significant element in the management plan for the safe and effective performance of the project. The objective of the Configuration Control system is to control the physical plant configuration, system status, work schedules, status tracking, and day-to-day problem resolution. Prior to the Decommissioning Operations Contractor (DOC) assuming operational responsibility for the Shippingport Plant, an assessment was made of the status of the configuration of the systems and related documentation. Action was taken as required to match the operating procedures and system documentation with the actual physical condition of the plant. During the first stage of the project, planning was put in place for subsequent decommissioning activities. This planning included defining organizational responsibilities, completing the necessary project instructions and procedures, and doing the planning and scheduling for the subsequent decommissioning phase activities. Detailed instructions for the performance of the various decommissioning tasks were prepared. Prior to the start of any work on a given Activity Package, a Work Authorization is required. The Work Authorization form provides a complete checklist to ensure that all necessary prerequisites are completed. A computerized Communications Configuration Control Information system monitors status including information on system status, tag-outs, radiological work permits, etc. An ongoing effort is being directed toward maintaining operating instructions and system schematics, etc. current as the Plant configuration changes. The experience with the Configuration Control System to date has been favorable.

37901 **(DOE/SSDP—0008) Asbestos removal at the Shippingport Station Decommissioning Project.** Davis, M.L.; MacLean, F.A.; Taylor, C.A.; Hendrickson, D.M. (General Electric Co., Shippingport, PA (USA). Nuclear Energy Business Operations; International Technology Corp., Shippingport, PA (USA)). 1986. Contract AC06-84RL10421;AC06-76RL01857. 4p. (CONF-860724—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011895.

From ASME/ANS bi-annual nuclear power conference: safe and reliable nuclear power plants; Philadelphia, PA, USA (20 Jul 1986).

Asbestos was used as an insulation material at the Shippingport Atomic Power Station on tanks, vessels, piping, duct work, building and equipment. It must be removed before any equipment disassembling and removal can be started. Asbestos is located in both Radiologically Controlled Areas (RCA) and Non-Radiologically Controlled Areas (Non-RCA) in the plant. Precautions and special handling procedures must be followed in order to minimize potential hazard to personnel and the environment. In the handling of asbestos material, guidelines can be found in the Code of Federal Regulations. A thorough survey was conducted to identify the location and quantity of asbestos in the plant. The amount of asbestos in the plant involves about 9000 linear feet of piping (100 cu. yard in volume) in the Non-RCA and 21,000 linear feet of piping (330 cu. yard in volume) in the RCA. This asbestos removal effort is expected to be completed at Shippingport within 12 months duration beginning August, 1985. In this paper, activities associated with asbestos removal, prerequisites to be performed before the project is started, sequence of operations, procedures and instructions, potential hazards and precautions and methods of disposal will be discussed. Recommendations for similar efforts in the future will be provided.

37902 **(DOE/SSDP—0009) Shippingport Station Decommissioning Project.** Schreiber, J.J. (USDOE Richland Operations Office, WA). 1986. Contract AC06-84RL10421;AC06-76RL01857. 78p. (CONF-8605136—1). NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86011894.

From International Atomic Energy Agency meeting; Marcoule, France (12 May 1986).

This report provides information on the Shippingport Reactor Station Decommissioning Project. (JDB)

37903 **(EPRI-NP—4620) Model of sludge behavior in nuclear plant steam generators. Final report.** Beal, S.K.; Chen, J.H. (Cohen (S.) and Associates, Inc., McLean, VA (USA)). Jun 1986. 144p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920344.

The accumulation of large amounts of sludge in pressurized water reactor steam generators is thought to be a cause of accelerated corrosion by trace impurities which concentrate in such deposits. Based on fundamental principles, this study develops a mathe-

matical model for predicting the behavior (e.g., deposition and reentrainment) of sludge in steam generators. The calculated sludge behavior shows good agreement with the limited amount of experimental data available. The results suggest that the continued accumulation of sludge on the tubesheet might be preventable, and that if it could be, the incoming sludge would be removed by blowdown. An analysis of the uncertainties in the model led to suggested priorities for further analytical and experimental work to gain a better understanding of sludge behavior. 29 refs., 12 figs., 15 tabs.

37904 **Bechtel's QA contribution to maintaining the reliability of San Onofre.** Reinsch, R.M. *Transactions of the American Nuclear Society;* **50**: 368(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The San Onofre nuclear generating station (SONGS) is an electrical power producing commercial facility principally owned and operated by Southern California Edison. Bechtel, as the prime engineer/constructor of the three operating units, has the responsibility of managing and performing a large portion of modification and retrofit activities during outages, as well as providing maintenance support to the owner during routine plant operations and outages. As part of its responsibility. Bechtel provides the owner with a full-scope quality assurance (QA) program that encompasses all of the QA tasks and responsibilities outlined by 10CFR50, Appendix B, and ANSI-N45.2 requirements and that is flexible enough to respond in the short time usually required to complete all outage work to return the plant to full operation. The purpose of this paper is to share with others in the nuclear power industry the experiences and lessons learned at SONGS and describe the ways in which this QA program makes a significant contribution to the reliability of SONGS.

37905 **Developing a system engineering program to improve performance and reliability.** Keuter, D. (Pacific Gas and Electric Co., Rainier, CA). *Transactions of the American Nuclear Society;* **50**: 376-377(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

After several maintenance, operational, and equipment problems last year, Trojan set out on a mission to improve plant performance and reliability by strengthening its on-site engineering organization. This paper presents Trojan's plans in developing an on-site system engineering organization.

37906 **Plant uprate: an economic evaluation and implementation approach.** Berryman, R.M.; Darden, G.L. (Virginia Power). *Transactions of the American Nuclear Society;* **50**: 388-389(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

There is a major trend within the utility industry toward increasing the availability and generating capacity of existing units that is caused by the increasing lead times, capital costs, and construction costs of new generating facilities. Increasing the electrical output of existing units is a less capital-intensive means to aid in meeting a utility's future load growth requirements. A major component of the Virginia Power plant improvement program is core thermal power uprating of its nuclear units. Nuclear plant upratings are of growing utility industry interest because of the large expected economic benefits. However, there are concerns regarding the impact on a plant's current operating license. The potential for core upratings was generally recognized by utilities and vendors by incorporating additional capacity in the original plant design. This was done with the understanding that increased thermal power ratings could be implemented in the future based on demonstrated levels of safety and operability. Safety-related features of a unit have been commonly designed for a thermal power ~5% above the original licensed rating. This creates the potential to uprate the unit's electrical capacity with only minor or no modifications to the plant. This paper presents Virginia Power's experiences regarding the benefits of nuclear plant uprating, outline their licensing approach, and describes current plans for implementation.

37907 **Impact of plant uprate on the balance-of-plant design of a PWR.** Banerjee, A.K.; Hanley, N.E.; McLellan, D.E. (Stone & Webster Engineering Corp.). *Transactions of the American Nuclear Society;* **50**: 389-391(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Increasing the electric output by uprating nuclear plants in one of the cheapest options for increasing energy generation capacity. Because nuclear power plants and components generally have been designed for power output greater than licensed rating, uprating of a nuclear power plant is primarily an exercise in reviewing documents, reviewing system and component capacity, revising some calculations, and obtaining US Nuclear Regulatory Commission (NRC) approval. Other than setpoint changes, hardware modifications are seldom required. Stone & Webster Engineering Corporation; together with Westinghouse, has recently completed uprating of a station with two three-loop pressurized water reactors (PWRs). The two organizations are performing a feasibility study for uprating of a similar station owned by the same utility. The feasibility studies and review process are described.

37908 **Evolution of an outage management organization in a small utility.** Oubre, R.P.; Shetler, J. (Sacramento Municipal Utility District, CA). *Transactions of the American Nuclear Society;* **50**: 397-399(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Six refueling outages with a number of major equipment failure outages have taught Rancho Seco management three main items. One is that a dedicated management organization must be formed for the purpose of controlling work functions at Rancho Seco. This dedicated organization must have the experience of the plant and not have the responsibility for the actual maintenance. Second, upper management within a power plant must get directly involved in the outage. Upper management must show their presence, give input, and be available when needed. The third item learned is that the scheduling organization must be adequately staffed. Although Rancho Seco completed a refueling outage in 1978 within only 36 days, additional inspection requirements due to regulatory changes and/or previous equipment failures requiring follow-up actions would place the shortest possible outage today at ~70 days. The only way an organization can keep this outage time down is with the proper scheduling of the resources and the timely coordination of activities to reduce conflicts.

37909 **Outage planning: basics are the key to success.** Helfand, N.B. (Northeast Utilities Service Company, Hartford, CT). *Transactions of the American Nuclear Society;* **50**: 399-400(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Northeast Utilities Service Company (NUSCO) services ~1,126,000 customers in Connecticut and western Massachusetts. The company's operating nuclear facilities include Connecticut Yankee, Millstone Unit 1, and Millstone Unit 2. Although NUSCO's earliest commercial operation of a nuclear plant dates back to January 1968, the cost and scheduling section was not created until 1979. The section was created as a corporate service organization composed of four major units: cost engineering, estimating, backfit/betterment planning, and outage planning. To date, 12 of the 28 nuclear refueling outages have been planned and scheduled by the department. There is now a wealth of outage information available from both company personnel and a historical computer database. Current directions within cost and scheduling have been back to basics. The backfit/betterment planning unit has been working with the in-house engineering and design groups to define their work scopes better, to develop a generic work breakdown structure, and to provide better resource planning. The estimating and cost engineering units are working to utilize this to provide true cost and schedule integration. Outage planning will wait for these developments on projects before discussing possible applications in the field.

37910 MDNBR 95/95 confidence interval determination for nonparametric CHF statistics. Giap, H.; Arias, J.; Best, F. (Texas A & M Univ., College Station). *Transactions of the American Nuclear Society;* 50: 408(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Houston Lighting and Power Company (HL & P), managing partner of the two-unit PWR South Texas Nuclear Project, has funded a project at Texas A & M University to investigate the implications of using nonparametric statistics to set the minimum departure from nucleate boiling ratio (MDNBR) thermal design limit. The major work of the project consists of developing a statistically correct procedure for establishing the MDNBR limit; however, industry peer review is also an important aspect of the work and the purpose of this summary is, therefore, two fold: to present the procedure that has been developed and to solicit industry comment on the procedure.

37911 Steam generator chemical cleaning at Millstone Point II. Oliver, T.W.; Thomas, R.C. *Transactions of the American Nuclear Society;* 50: 408-410(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Northeast Utilities chemically cleaned their Combustion Engineering U-tube steam generators utilizing a variation of the Electric Power Research Institute (EPRI)-developed steam generator cleaning solvent qualified specifically for the Millstone 2 plant. The cleaning was required due to a buildup of corrosion products in the tube sheet area, which was causing tube pitting. This effort is particularly significant because it is the first chemical cleaning performed on commercial nuclear steam generators and clearly shows that chemical cleaning is a viable maintenance tool for steam generator life extension. This paper describes the equipment and the on-site effort required to perform this task, including: preplanning, procedure development, equipment installation and checkout, personnel safety, environmental concerns, and the cleaning operation.

37912 Goesgen: a nuclear power station with an excellent performance record. Truempy, E. (KKG-Switzerland). *Transactions of the American Nuclear Society;* 50: 491-492(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The nuclear power plant Goesgen (KKG) in Switzerland with an output of 970 MW (gross) is equipped with a reactor of the pressurized water reactor type. Commercial operation started in November 1979. In this report, a brief survey of the construction and starting period is given, followed by the most important technical data as well as some information about the cost of construction. The most important problems and modifications of plant components that have taken place since the beginning of operation are: 1) replacement of the feedwater tank; 2) retubing of the condenser (stainless steel instead of brass); 3) replacement and modification of turbine blades; and 4) problems with the main coolant pumps. Special attention is focused on the experience with the steam generators. Satisfactory results in operation records are based on the good behavior of the fuel. Therefore, some remarks on the fuel and the fuel cycle of KKG are made. Excellent operation of a power station causes low energy production costs, so some information on the economy of KKG are presented. With respect to efficient operation of a nuclear plant, the main points discussed are: general design of the nuclear power station, quality of the components, maintenance, and, last but not least, the training and motivation of the operating staff.

37913 Elimination of reactor trips caused by single CEA drops through improvements in the reactor protection system. Chiu, C.; Reilly, J.T. (Southern California Edison). *Transactions of the American Nuclear Society;* 50: 496-498(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

During the startup and initial operation phases of San Onofre Nuclear Generating Station Units 2 and 3, many trips caused by actual and spurious single control element assembly (CEA) drop events were experienced. The causes include malfunctions from CEA position indicator(s); the CEA calculator (CEAC), which calculates the thermal margin penalty factor during CEA deviation events; and gripper latches. The frequency of trips related to single CEA drop events experienced by San Onofre Nuclear Generating Station Units 2 and 3 is as high as five trips per reactor year between August 1982 and November 1983, during the initial phase of operation. This paper describes the improvements made to the reactor protection system for San Onofre Nuclear Generating Station Units 2 and 3 that have been proved to avoid effectively any trips caused by a single CEA drop event.

37914 B & W owners group scram reduction efforts. Rose, S.T. (Duke Power Co.). *Transactions of the American Nuclear Society;* 50: 498-499(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Reducing the frequency of reactor scrams is an important and highly visible task. Scram frequency is one indicator of how consistently a unit is operated within desired bounds and hence is a key performance indicator. To be successful and efficient in this undertaking, diligent effort by the individual utilities should be complimented by collective action to resolve generic problems. The Babcock & Wilcox (B & W) Owners Group is committed to improving the productivity of its operating units and, in particular, to reducing the number of scrams experienced at the units. Toward this goal, the owners group has undertaken several initiatives to improve the reliability and performance of systems that historically have reactor trips. This paper describes those efforts and how they were identified.

37915 Improved reactor trip breaker reliability for pressurized water reactors. Redmon, J.R.; Borchart, D.J. (Southern California Edison). *Transactions of the American Nuclear Society;* 50: 500-502(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Reactor trip breaker (RTB) reliability has been a major concern of the industry and the US Nuclear Regulatory Commission because of the incident with Westinghouse RTBs at Salem Unit I. A similar problem occurred at San Onofre Units 2 and 3 with General Electric (GE) RTBs. An investigation concluded that the reliability of GE AK-2-25 low voltage breakers used as RTBs can be substantially improved by replacing the undervoltage trip device with an alternating current (ac) shunt trip device. This paper proposes a design change that has been experimentally verified as sufficient torque force to reliably open the breaker and is considered failsafe. Problems with GE AK-2-25 breakers used as RTBs have been almost exclusively related to the undervoltage trip (UV) device's ability to open the breaker. RTBs typically employ two means of opening on a trip signal: (a) an undervoltage trip attachment operating in a loss-of-voltage (failsafe) mode and (b) a shunt trip attachment requiring electric power to function (diverse method). Investigation determined breaker bearing lubrication and UV device electrical/mechanical adjustments are critical to breaker openings as the UV device has marginal tripping force.

37916 Artificial intelligence applications to the surveillance and diagnostics of nuclear power plants. Zwingelstein, G.; Monnier, B. (Electricite de France). *Transactions of the American Nuclear Society;* 50: 515-516(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Artificial intelligence has come of age; it can be applied with benefits in the nuclear industry for various applications to improve both plant safety and availability. This paper presents four rule-based expert systems currently under development at Electricite de France for the surveillance and the diagnostics of pressurized water reactors (PWRs). The objectives of these experiences with expert system projects are to demonstrate their feasibility, to provide an evaluation of their potential benefits through on-site implementation, to identify the problems due to the knowledge extraction and representation, and finally to specify the classes of problems where expert systems are needed and useful. The specific goals of these

expert systems are to provide an aid for the detection and location of failures occurring in nuclear plants.

37917 Prototype for an automated technical specification information system. Quinn, E.L.; Mills, R.H.; Groves, J.E. *Transactions of the American Nuclear Society;* **50**: 516-518(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Southern California Edison (SCE) Automated Technical Specification Information System (ATSIS) at the San Onofre nuclear generating station (SONGS) has been developed as a prototype for an on-line information management system. This system provides an appropriate level of update, inquiry, and report generation capabilities to help support plant operators at SONGS in their efforts to anticipate, identify, document, and track certain actions and activities associated with plant technical specifications and associated limiting conditions of operation (LCOs). Substantially increased emphasis is being placed on adherence to nuclear regulatory requirements and commitments contained on the operating licenses of nuclear power plants. Additionally, as each year passes, such requirements are becoming increasingly detailed and complex, making it more and more difficult to track and ensure total compliance with the many and varied requirements. To assist the operations department at SONGs in meeting their regulatory commitments, in January 1985 SCE commenced gathering together the leading technical expertise available in the industry to develop a computerized system to track all technical specification-related equipment for operability and impact on LCOs.

37918 Nuclear power plant operating performance in Korea. Chung, B.H. (Korea Electric Power Corp., Seoul). *Transactions of the American Nuclear Society;* **50**: 520(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Republic of Korea does not have sufficient energy resources to meet the rapid growth of its national economy. Coal, which has been the most important domestic energy source, is limited, and neither oil nor natural gas resources has been found. The Korea Electric Power Corporation (KEPCO) took an ambitious stem toward a nuclear power generation program. Since the start of commercial operation of Korea Nuclear Unit 1 (KNU-1) in 1978, the number of nuclear power plants has increased to three units with an output of 1961 MW(e). The capacity of these three operating nuclear units accounts for 13.5% of the total installed electric capacity in Korea. The average capacity factor in 1984 of the three current units reached 70.1% and is expected to be >73.5% in the 1985. The capacity factor of Korea Nuclear Unit 2 was especially high, with 214 days of continuous full-power operation recorded early this year. This excellent performance is considered to be the result of strict quality assurance activities and KNU-1 experience. KEPCO has recently established long- and short-term plans to improve the availability and capacity factors of the nuclear power plants. Emphasis is focused on the reduction of forced outages, shortening of the overhaul period, and extension of the operating cycle.

37919 Simplified method to identify causes of PWR electrical output losses. Chiu, C.; Quigley, N.J. (Southern California Edison Company). *Transactions of the American Nuclear Society;* **50**: 521-522(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper describes the method developed at Southern California Edison Company that is used routinely to identify major causes of electrical output [MW(e)] change and their associated rates of degradation for San Onofre nuclear generating station pressurized water reactors Units 2 and 3. This information is very important to utility management in terms of timely institution of corrective maintenance actions on a cost-effective basis. It is well known that the causes for electrical output degradation are generally from the following sources: high condenser backpressure, reactor thermal power measurement error, moisture-separator reheater degradation, low steam generator pressure, feedwater heater thermal performance, throttle loss in turbine control valves, energy loss in steam generator blowdown flow, degradation in turbine performance, and leaking valves (cycle isolation). To quantify the MW(e) loss associated with each of the seven items, two tasks have to be performed. One is to choose several measurable operating parameters that are independent and sufficient to evaluate the thermal performance related to each item. The other is to develop those sensitivity factors that relate the change in the total electrical output to the changes of the chosen operating parameters.

37920 Use of a PDQ-8 depletion method for high-speed design accuracy. Bagnal, C.W.; Dooley, G.D.; Poetschat, G.R.; Cacciapouti, R.J.; Evinay, A. *Transactions of the American Nuclear Society;* **50**: 531-532(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Nuclear power reactor licensing requires analyses of detailed fuel pin power distributions of thermal margin and safety assessments. With 40,000 to 50,000 fuel pins in a typical pressurized water reactor core, this task is both engineering labor and computer resource intensive. The industry standard for these computations has been the PDQ-7 fine-mesh diffusion code. To reduce costs and increase productivity, electric utilities have sought to develop alternative methods that achieve the accuracy and utility of PDQ-7 without the traditionally high cost. An alternative that reduces many of these costs is the PDQ-8 code. A recent study by GRP Consulting, Yankee Atomic, and Control Data suggests the use of PDQ-8 to achieve PDQ-7 fine-mesh point depletion accuracy employing coarse block depletion strategies. The results of this study suggest that the use of the PDQ-8 gross block/fine block depletion methodology, with the proposed improvement, could reduce overall computer requirements for nuclear plant reload licensing and core follow physics calculations. Furthermore, PDQ-8 is essentially an enhanced version of PDQ-7; utility engineering staff retraining requirements for PDQ-8 adoption are minimized.

37921 Self-adjointness of the fast flux in a pressurized water reactor. Mosteller, R.D. (S. Levy, Inc., Campbell, CA). *Transactions of the American Nuclear Society;* **50**: 533-536(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Most computer codes for the analysis of systems transients rely on a simplified representation of the active core, typically employing either a one-dimensional or a point kinetics model. The collapsing of neutronics data from multidimensional steady-state calculations normally employs flux/flux-adjoint weighting. The multidimensional calculations, however, usually are performed only for the forward problem, not the adjoint. The collapsing methodologies employed in generating the neutronics input for transient codes typically construct adjoint fluxes from the assumption that the fast flux is self-adjoint. Until now, no further verification of this assumption has been undertaken for thermal reactors. As part of the verification effort for EPRI's reactor analysis support package, the validity of this assumption now has been investigated for a modern pressurized water reactor (PWR). The PDQ-7 code was employed to perform two-group fine-mesh forward and adjoint calculations for a two-dimensional representation of Zion Unit 2 at beginning of life, based on the standard PWR ARMP model. It has been verified that the fast flux is very nearly self-adjoint in a PWR. However, a significant error can arise during the subsequent construction of the thermal adjoint flux unless allowance is made for the difference between the forward and adjoint thermal buckling terms. When such a difference is included, the thermal adjoint flux can be estimated very accurately.

37922 Stochastic modeling of an at-power pressurized water reactor. Perez, R.B.; Wood, R.T. (Univ. of Tennessee, Knoxville). *Transactions of the American Nuclear Society;* **50**: 544-545(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

A stochastic model of a pressurized water reactor (PWR) system has been developed to assess the feasibility of using stochastic methods as tools for power reactor surveillance and diagnostics. In this model, the reactor system is represented by coupled modules of equations describing the dynamic behavior of reactor core and

steam generator field variables. Fits of the model predictions to experimental power reactor noise data have been performed to demonstrate the validity of using stochastic models to represent the dynamic state of the PWR system. Ultimately, stochastic models could be used with advanced parameter estimation techniques to monitor the behavior of a power reactor system.

37923 **Use of UO_2-Gd_2O_3 in very low leakage, extended burnup fuel cycles.** Hove, C.M. (Babcock & Wilcox Co.). *Transactions of the American Nuclear Society;* **50**: 555(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The US Department of Energy, Duke Power Company, and Babcock & Wilcox Company are participating in an extended burnup program for pressurized water reactors. Under this program, an advanced fuel assembly has been designed and is being tested for batch-average discharge burnups >50,000 MWd/MTU. One feature of this advanced fuel assembly that improves its economic potential is the use of UO_2-Gd_2O_3 (urania-gadolinia) as a fuel burnable absorber mixture. Previous milestones in the gadolinia development of the extended burnup program include: development and verification of a neutronics model, measurement of materials properties of gadolinia fuel, and successful irradiation of gasolinia lead test assemblies (LTAs) for the first one-and-a-half cycles of a planned four-cycle residence. Another phase of the gadolinia development effort is a study of full-batch implementation of gadolinia in very low leakage, extended burnup fuel cycles. This paper presents results from this phase. Gadolinia has been shown to be a feasible alternative to B_4C LBP clusters in very low leakage extended burnup fuel cycles.

37924 **Use of gadolinium in PWR cores: the effects on local power and on nodal normalization.** Rothleder, B.M. (SAIC, McLean, VA). *Transactions of the American Nuclear Society;* **50**: 557-559(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Past studies have shown that judicious loading of gadolinium (Gd_2O_3) as a distributed burnable absorber in pressurized water reactor cores can result in improved power shapes, lower peaking factors, a more negative moderator temperature coefficient, and increased control rod worth. These and other such studies, however, either have not addressed or have not published information about local power behavior and the validity of standard nodal normalization procedures. Gadolinium depletion characteristics suggest that x,y pin (or local) power peaking behavior and validity of nodal normalization prior to imposing feedback be reexamined. As in past studies, a Westinghouse 157-assembly, 17 x 17 lattice core with both borosilicate and axially zoned 2 and 3 wt% Gd_2O_3 burnable absorbers was analyzed through first cycle using the ARMP/SIMULATE code system, modified to treat gadolinium. Results are as follows: 1) The x,y pin peaking in gadolinium designs is essentially the same as that in conventional designs, but shows significantly greater radial migration. 2) The maximum feedback-initiated x,y assembly power change in gadolinium designs is twice that in conventional designs, thus increasing any inaccuracy incurred by the super-position of feedback effects on x,y parameters. 3) Axial normalization of nodal codes may require explicit evaluation for gadolinium designs.

37925 **Utilization of gadolinium burnable poison for reactivity control of pressurized water reactors.** Galperin, A.; Segev, M. (Ben-Gurion Univ., Beersheba, Israel). *Transactions of the American Nuclear Society;* **50**: 559-560(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Summarized here is an attempt to utilize gadolinium as a burnable poison for total reactivity control of a PWR core equilibrium cycle, i.e., control without a soluble poison system. In the course of the research, a few design guidelines evolved: 1) gadolinium can be utilized well in the form of a lumped poison rod; 2) the optimal gadolinium rod is an annulus of gadolinium immersed in water; 3) BP rods are inserted into vacant thimble guide tubes; and 4) only fresh fuel assemblies are loaded with BP rods, thus avoiding insertion of the BP clusters into irradiated fuel assemblies.

37926 **GEDEON 1: a first interpretation of a benchmark experiment for UO_2-Gd_2O_3 depletion in PWR assemblies.** Do, Q.Q.; Doutriaux, D.; Zero, S. (Framatome, Courbevoie, France). *Transactions of the American Nuclear Society;* **50**: 560-562(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The French nuclear power program optimization requires an 18-month cycle strategy. This goal can be reached by using burnable absorbers. The selected material is gadolinium oxide because of its reprocessing capabilities. To qualify Framatome neutronics calculational methods for UO_2-Gd_2O_3 pins, two experiments were carried out in a joint venture with the Commissariat a l'Energie Atomique: CAMELEON, to study the interactions of undepleted UO_2-Gd_2O_3 ins and GEDEON 1, to investigate the depletion of UO_2-Gd_2O_3 pins. This paper presents a first interpretation of the results currently available on GEDEON 1. Since standard neutronic calculational methods are not applicable in the case of UO_2-Gd_2O_3, Framatome developed some new calculational methods, which have to be validated by comparison with the experiments.

37927 **San Onofre Unit 1 reactivity change due to extended shutdown.** Ramendick, D.J.; Miller, D.J. (Southern California Edison Co.). *Transactions of the American Nuclear Society;* **50**: 568-569(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Few nuclear reactors have been shut down for periods on the order of several years - and then restarted. Those that have experienced this type of history are sources of a great deal of information concerning reactivity changes and in-core power redistributions due to nuclide decay. This paper discusses the core reactivity changes due to this nuclide decay and presents actual data illustrating the net effect of these changes on the critical boron concentration (CBC) rundown curve and the in-core power distribution at the San Onofre Nuclear Generating Station Unit 1 (SONGS-1).

37928 **Calculation of neutron sources and spectra in a PWR fuel.** Wilson, W.B.; Stewart, J.E.; England, T.R.; Perry, R.T. (Los Alamos National Lab., NM). *Transactions of the American Nuclear Society;* **50**: 569-571(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The SOURCES code and library, under development for the past 5 yr, calculate β,n delayed, spontaneous fission (SF), and (α,n) neutron sources and spectra due to the decay of an input inventory of radionuclides in homogeneous media. These neutron spectra are now supplemented by photoneutron spectra calculated with PHONX84, an evolved version of PHONEX. The PHONX84 code uses an input gamma energy-binned fluence and deuterium atom density, and evaluated $^2H(\gamma,n)$ photoelectric and photomagnetic cross sections using isotropic photomagnetic and $\sin^2$ theta photoelectric neutron angular distributions in the CM system. The combined SOURCES/PHONX84 capability has been demonstrated in the calculation of the neutron source in discharged 31.5 GWd/tU PWR fuel for cooling times extending to 100 yr.

37929 **Observation of denting and other deterioration in the surry steam generator.** Clark, R.A.; Lewis, M. (Pacific Northwest Lab.). pp 193-196 of Proceedings of the international conference on nuclear power plant aging, availability factor and reliability analysis. Goel, V.S. Metals Park, OH; American Society of Metals (1985). (CONF-850713—).

From International conference on nuclear power plant aging, availability factor and reliability analysis; San Diego, CA, USA (7 Jul 1985).

A Westinghouse type 51 steam generator has been the subject of extensive nondestructive and destructive examination. The Steam Generator Group Project acquired the A generator removed from the Surry 2 nuclear station after less than six years of service. At the time of replacement, this generator had ≈22% of its tubes plugged due to indicated defects or as a preventive measure. The generator had known wastage, stress corrosion cracking and denting damage to tubes when removed from service. Subsequent investigations has characterized severe support plate degradation, dent-

ing in the tube sheet, pitting the sludge pile and potential IGA at the top of the tube sheet. The extent and characterization of this damage are discussed in the paper.

2103 Power Reactors, Non-breeding, Graphite Moderated

REFER ALSO TO CITATION(S) 37981, 38042

37930 **(GA-A—18408) Steam generator design considerations for modular HTGR plant.** McDonald, C.F.; DeFur, D.D. (GA Technologies, Inc., San Diego, CA (USA)). May 1986. Contract AC03-84SF11963. 9p. (CONF-860724—9). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012103.

From ASME/ANS bi-annual nuclear power conference: safe and reliable nuclear power plants; Philadelphia, PA, USA (20 Jul 1986).

Studies are in progress to develop a standard High Temperature Gas-Cooled Reactor (HTGR) plant design that is amenable to serial production and is licensable. Based on the results of trade studies performed in the DOE-funded HTGR program, activities are being focused to emphasize a modular concept based on a 350 MW(t) annular reactor core with prismatic fuel elements. Utilization of a multiplicity of the standard module affords flexibility in power rating for utility electricity generation. The selected modular HTGR concept has the reactor core and heat transport systems housed in separate steel vessels. This paper highlights the steam generator design considerations for the reference plant, and includes a discussion of the major features of the heat exchanger concept and the technology base existing in the US.

37931 **Conceptual study of a nuclear plant used for seabed electrical power.** Rogers, V.C.; Sandquist, G.M.; Murray, T.M. (Rogers & Associates Engineering Corp., Salt Lake City, UT). *Transactions of the American Nuclear Society;* **50**: 431-432(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

A conceptual engineering study of feasible nuclear power plants that might be employed to provide in situ electrical power needs for certain subsea operations is presented. The operations occur ~200 km from shore at a depth of over 300 m. About 20 MW(e) of electrical power is required. Surface power platforms are deemed to be impractical because of severe weather and other conditions. A possible solution, now under investigation is an in situ subsea nuclear plant that would have a high degree of reliability and would require minimal on-site personnel time. Obviously, such a self-contained nuclear power plant in a remote, subsea environment must be inherently safe, environmentally innocuous, reliable, and require refueling and major maintenance only after several years for profitable operation. The essential elements of this conceptual study are discussed.

37932 **Search for excellence: gas-cooled reactors in the United Kingdom.** Pexton, A.F. (South of Scotland Electricity Board, Glasgow). *Transactions of the American Nuclear Society;* **50**: 485-486(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The development of the gas cooled reactor program in the United Kingdom is discussed with respect to the following: the historical circumstances that led the UK to develop the gas cooled reactors, design improvements since the first generation of reactors, various designs being pursued with the advanced gas cooled reactors, current and planned construction, and possibilities for using the gas cooled reactors for breeding.

2104 Power Reactors, Non-breeding, Otherwise Moderated Or Unmoderated

37933 **Proven program for valve stem leakage reduction.** Schoen, G.F.; Issid, N. (NUS Corp., Clearwater, FL). *Transactions of the American Nuclear Society;* **50**: 406-408(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

It has long been recognized that repacking of valves in nuclear power stations takes an excessive amount of manpower and causes plant personnel to receive unnecessary radiation exposure. This used to be a problem in the Canadian nuclear stations, which had the additional problem that the heavy water coolant costs approximately $1200 per gallon and is too expensive to lose through valve leakage. In the late 1960s, the Atomic Energy of Canada Limited (AECL) undertook development of a technology to reduce valve leakage significantly and to maximize the life of valve packing. After extensive investigation, cost-effective technology was developed to achieve both of these goals, as well as to essentially eliminate the need for periodic tightening of valve packing. This innovative technology, known as live-loading, has been used in all Canadian CANDU nuclear plants for the past 14 yr - and in some Canadian fossil plants as well. In the nuclear plants, live-loading is used on essentially all valves in both the primary and secondary circuits.

37934 **Search for excellence: a progress report on Point LePreau.** Macloon, F.C.; Sommerville, J. (New Brunswick Electric Power Commission, Point LePreau). *Transactions of the American Nuclear Society;* **50**: 486-487(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

In 1974, the New Brunswick Electric Power Commission (NBEPC) committed itself to the construction of Point Lepreau. Major construction work began in 1975 and despite a sometimes difficult construction environment, full-power operation was achieved in March 1983. Although started third in a series of four similar 600-MW(e) CANDU reactors, Point Lepreau was the first to achieve criticality and commercial service. The early operation of Point Lepreau has been very successful with a gross capacity factor since in-service of ~90%. The paper includes the criteria used to judge the performance of Point Lepreau and compares them to other plants. Obviously, success in a small organization initially lacking the infrastructure to support a nuclear program has required unique approaches. This paper attempts to illustrate the key elements that NBEPC feels contributed significantly to the achievement of the overall reliability that has been achieved in the operating plant. Most of the paper is devoted to the significant efforts, often unique in their concept and application, undertaken during the precommissioning, commissioning, and the initial and on-going operating phases.

37935 **Pursuit of excellence: Canada's successful CANDU program.** Jackson, H.A. (Ontario Hydro, Toronto). *Transactions of the American Nuclear Society;* **50**: 492-493(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper deals primarily with the Ontario Hydro utility's management of its CANDU-PHW reactors. Management by objectives is discussed with respect to worker safety, public safety, environmental protection, reliability, and product cost. An overview is presented of reasons for the excellence achieved in the operation of the reactors both in Canada and abroad.

2105 Power Reactors, Breeding

REFER ALSO TO CITATION(S) 38013, 38018, 38019

37936 **(PNL-SA—13727) Effects of irradiation on crack propagation during creep.** Gilbert, E.R.; Chin, B.A.; Duncan, D.R. (Pacific Northwest Labs., Richland, WA (USA); Auburn Univ., AL (USA); Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Jun 1986. Contract AC06-76RL01830. 34p. (CONF-860605—15). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012329.

From 13. international symposium on the effects of radiation on materials; Seattle, WA, USA (23 Jun 1986).

In-reactor stress to rupture results in excess of 11,000 hours are reported. Stress rupture properties during in-reactor testing of AISI 316 CW were demonstrated to be greater than or equal to the unirradiated material properties. Failure strains of the presurized tube specimens were found to be stress dependent with a minimum in failure strain occurring at 200 Mpa for unirradiated tests. Higher failure strains at lower stresses resulted from a transition in crack propagation mechanisms from triple point wedge cracking to grain boundary cavitation. Irradiation was found to shift to lower stresses the triple point cracking to cavitation transition. 18 figs., 20 refs.

37937 **(NE-F—9-4T-Rev.-2/84) Requirements for design of Class 1 elevated temperature nuclear system components (supplement to ASME Code Case N-47).** (Oak Ridge National Lab., TN (USA)). 30 Jun 1986. Contract AC05-84OR21400. 24p. Performance Assurance Project Office, ORNL building 9204, Rm. 321 P.O. Box Y Oak Ridge, TN 37831. File Number TI86012478.

This standard provides rules for the design of Class 1 nuclear components for use at elevated temperatures. It constitutes a complete set of requirements only when used in conjunction with Section III of the ASME Boiler and Pressure Vessel Code (ASME Code) and addenda, and ASME Code Case N-47. Unmodified portions of Code Case N-47 are not repeated in this standard but are considered requirements of this standard.

37938 **Method for removing cesium from a nuclear reactor coolant.** Colburn, R.P. (to Dept. of Energy, Washington, DC). US Patent 4,587,083. 6 May 1986. Filed date 10 Aug 1983. vp.

A method for removing cesium from a liquid metal circulating through a primary cooling system of a nuclear reactor is described which consists of: providing a primary carbon packing trap in the primary system, continually absorbing cesium from the coolant onto the carbon packing trap at a relatively low temperature until the trap is substantially saturated with cesium, isolating the primary trap when saturated from the primary system by disconnecting the trap therefrom and connecting the primary trap to a closed regeneration flow system having a secondary carbon packing trap. The closed regeneration flow system is completely isolated from the primary coolant system and having a volume substantially smaller than the primary coolant system, increasing the temperature of the coolant passing through the primary trap, diffusing a portion of the cesium inventory on the surface of the primary trap further into the matrix thereof while dispersing a portion of the cesium inventory into the coolant circulating through the regeneration flow system, reducing the temperature of the coolant passing through the secondary trap, and physically and chemically absorbing cesium from the coolant in the regeneration flow system onto the secondary carbon packing trap until cesium equilibrium between the traps is reached whereby the primary trap is reconditioned for further usage when reconnected to the primary system.

37939 **(NE-M—14-2T-Rev.-1/86) Fuel and control assembly tag gas.** (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1986. Contract AC06-76FF02170. 18p. Performance Assurance Project Office, ORNL Building 9204, Rm. 321, Box Y, Oak Ridge, TN 37831. File Number TI86012475.

This standard establishes the requirements for tag gas to be used for locating failed fuel pins and control rod absorber pins in the reactor by the failure monitoring system. Tag gas shall consist of varying isotopic mixtures of xenon, krypton, or other gases as specified in the Ordering Data.

37940 **(NE-E—13-16T-Rev.-1/86) Fast breeder reactor fuel assembly.** (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1986. Contract AC06-76FF02170. 17p. Performance Assurance Project Office, ORNL building 9204, Rm. 32121 P.O. Box Y Oak Ridge, TN 37831. File Number TI86012255.

This standard establishes the requirements for fabrication, testing, and inspection of fuel assemblies for use in liquid metal fast breeder reactors.

37941 **Breeder development in Europe and the United States: similar goals, different approaches.** Marth, W. *Transactions of the American Nuclear Society;* 50: 406(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Breeder reactor development in Europe is a more pressing issue than in the United States. In both regions, however, the general goals for breeder development are similar, although the approaches for reaching them are currently rather different. This paper deals briefly with this ambiguity by discussing research and planning considerations in the US and the design and construction on-going in the European countries.

37942 **Fast reactor analysis by means of the equivalent generalized perturbation theory.** Gandini, A.; Palmiotti, G.; Salvatores, M. (ENEA - Italy). *Transactions of the American Nuclear Society;* 50: 543-544(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Based on well-established generalized perturbation theory (GPT) methodology, an equivalent, general formulation is illustrated. An advantage of this formulation, referred to as EGPT, is that in many circumstances, calculation of functions entering the perturbation expressions may be simpler. The general formulation is presented first. Then its application to different reactor physics problems is given. Numerical tests for a few cases relevant to a large fast breeder reactor are given last.

37943 **Operability predictions and results for the Liquid Sodium Breeder Reactor Primary Pump.** Guardiani, R.F.; Nyilas, C.P. (Westinghouse Electro-Mechanical Div., Cheswick, PA). pp 277-284 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-9. Piping, feedwater heater operations and pumps. Hollinger, G.L. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—).

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

The analytical techniques used for the operability analysis of the Liquid Sodium Breeder Reactor Primary Pump over the entire operating envelope for various service conditions are described. The predicted results are compared where applicable with actual water test data.

37944 **Liquid Sodium Breeder Reactor Primary Pump water test dynamic analysis predictions and results.** Mastandrea, M.F.; Guardiani, R.F. (Westinghouse Electro-Mechanical Div., Cheswick, PA). pp 285-292 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-9. Piping, feedwater heater operations and pumps. Hollinger, G.L. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—).

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

Lateral natural frequency and vibration response analyses of the Liquid Sodium Breeder Reactor (LSBR) Primary Pump and loop were performed to support water loop testing of the pump. The special features of the pump modeling are outlined in this paper. Also, a method of computing the maximum relative and absolute steady state responses and associated phase angles at given locations is provided. The analytical results are compared with actual water test data.

37945 **Reliability and extended-life potential of EBR-II.** King, R.W. (Argonne National Lab., Idaho Falls, ID). pp 667-670 of Proceedings of the international conference on nuclear power plant aging, availability factor and reliability analysis. Goel, V.S. Metals Park, OH; American Society of Metals (1985). (CONF-850713—). Contract W-31-109-ENG-38.

From International conference on nuclear power plant aging, availability factor and reliability analysis; San Diego, CA, USA (7 Jul 1985).

Although the long-life potential of liquid-metal-cooled reactors (LMRs) has been only partially demonstrated, many factors

point to the potential for exceptionally long life. EBR-II has the opportunity to become the first LMR to achieve an operational lifetime of 30 years or more. In 1984 a study of the extended-life potential of EBR-II identified the factors that contribute to the continued successful operation of EBR-II as a power reactor and experimental facility. Also identified were factors that could cause disruptions in the useful life of the facility. Although no factors were found that would inherently limit the life of EBR-II, measures were identified that could help ensure continued plant availability. These measures include the implementation of more effective surveillance, diagnostic, and control systems to complement the inherent safety and reliability features of EBR-II. An operating lifetime of well beyond 30 years is certainly feasible.

37946 **Review of effects of long-term aging on the mechanical properties and microstructures of types 304 and 316 stainless steel.** Horak, J.A.; Sikka, V.K.; Raske, D.T. (Oak Ridge National Lab., Oak Ridge, TN). pp 301-314 of Proceedings of the international conference on nuclear power plant aging, availability factor and reliability analysis. Goel, V.S. Metals Park, OH; American Society of Metals (1985). (CONF-850713—). Contract AC05-84OR21400.

From International conference on nuclear power plant aging, availability factor and reliability analysis; San Diego, CA, USA (7 Jul 1985).

Because commercial liquid metal fast breeder reactors (LMFBRs) are designed to last for 40 years or more, an understanding of the mechanical behavior of the structural alloys used in them is required for times on the order of 2.5×10^5 h (assuming a 70% availability factor). Types 304 and 316 stainless steel are used extensively in LMFBR systems. At the beginning of life these alloys are in a metastable state and evolve to a more stable state and, therefore, more stable microstructure during plant operation. Correlations of microstructures and mechanical properties during aging under representative LMFBR temperature and loading conditions are desirable from the standpoint of assuring safe, reliable, and economic plant operation. The authors reviewed the mechanical properties and microstructures of types 304 and 316 stainless steel wrought alloys after long-term aging in air for times up to 9×10^4 h (about 10-1/2 years). The principal effect of such aging is to reduce low temperature fracture toughness (as measured by Charpy impact tests) and tensile ductility. Examples are cited, however, where, because stable microstructures are achieved, these as well as strength-related properties can be expected to remain adequate for anticipated service life conditions.

2106 Power Reactors, Auxiliary, Mobile, Package, And Transportable

REFER ALSO TO CITATION(S) 37769, 38061

37947 **(DOE/NASA/1005—8) Overview of free-piston Stirling SP-100 activities at the NASA Lewis Research Center.** Slaby, J.G. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. Contract AI05-82OR21005. 25p. (NASA-TM—87224; CONF-860676—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86006660.

From 3. international Stirling engine conference; Rome, Italy (1 Jun 1986).

An overview of the National Aeronautics and Space Administration (NASA) Lewis Research Center (LeRC) SP-100 free-piston Stirling engine activities is presented. These activities are being conducted in support of the Department of Defense (DOD), Department of Energy (DOE), and NASA. The space-power technology effort, under SP-100, addresses the status of the 25 kWe Space Power Demonstrator Engine (SPDE). Another facet of the SP-100 project covers the status of an endurance test. Dynamic balancing of the SPDE engine will be discussed along with a summary covering the parametric results of a study showing the relationship between power-converter specific weight and efficiency both as a function of Stirling engine heater to cooler temperature ratio. Design parameters and conceptual design features will be presented for a 25 kWe, single-cylinder free-piston Stirling space-power converter. And finally, a description of a hydrodynamic gas bearing concept will be presented.

37948 **(GPO—5-987) Space nuclear power generation, conversion and storage for the nineties and beyond. Subcommittee on Energy Research and Production to the Committee on Science and Technology, 99th Congress, First Session.** (Committee on Science and Technology (U.S. Congress. House), Washington, DC). 1986. 19p. GPO.

Concerns and interests in the development of space nuclear power systems for civilian and defense applications were reaffirmed. Government policy issues affecting the potential implementation of such systems were addressed. The status of the technology was reviewed. Innovative approaches to development of advanced nuclear power systems for space were explored.

37949 **Thermal-hydraulic and neutronic interaction in the rotating bed reactor.** Lee, C.C.; Jones, O.C. Jr.; Becker, M. (Rensselaer Polytechnic Institute, Troy, NY). *Transactions of the American Nuclear Society;* 50: 572-574(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

To obtain high power density, the rotating fluidized bed reactor (RBR) presents an attractive option for both space nuclear propulsion systems and prime space platform power. This reactor concept achieves very high power density by using small spherical fuel particles of ~500 μm in diameter, fluidized inside a rotating porous cylinder. For maneuvering purposes, the RBR is expected to have frequent perturbations of gas coolant/propellant flow rate, which may result in power level transients caused by the coupling between thermal hydraulics and neutronics. Besides having negative reactivity for the thermal response of fuel and coolant as in conventional reactors, the RBR can have a positive feedback parameter due to fuel bed expansion. The inherent interaction between thermal hydraulics and neutronics following a gas flow rate perturbation had been analyzed for the infinitely long RBR system, where neutron leakage through the exhaust nozzle was neglected. In this paper, a finite, quasi-one-dimensional fuel bed model is described including the effect of neutron leakage through the end nozzle.

37950 **Space reactor fuels performance and development issues.** Wewerka, E.M. (Los Alamos National Lab., NM). pp 306-311 of IECEC '84: Advanced energy systems - their role in our future; Proceedings of the Nineteenth Intersociety Energy Conversion Engineering Conference, San Francisco, CA, August 19-24, 1984. Volumes 1, 2, 3, & 4. La Grange, Park, IL; American Nuclear Society (1984). (CONF-840804—).

From Intersociety energy conversion engineering conference; San Francisco, CA, USA (19 Aug 1984).

Three compact reactor concepts are now under consideration by the U.S. Space Nuclear Power Program (the SP-100 Program) as candidates for the first 100-kWe-class space reactor. Each of these reactor designs puts unique constraints and requirements on the fuels system, and raises issues of fuel systems feasibility and performance. This paper presents a brief overview of the fuel requirements for the proposed space reactor designs, a delineation of the technical feasibility issues that each raises, and a description of the fuel systems development and testing program that has been established to address key technical issues. 5 references.

2107 Regulation And Licensing

REFER ALSO TO CITATION(S) 37896, 37897, 37898, 37899, 37900, 37901, 37902, 38040

37951 **(EPRI-NP—4615) ASME Code, Section XI. Inservice inspection of nuclear power plant components. 1984-1985 revisions and updates. Final report.** Mattu, R.K.; Frank, L.; Shriner, C. (Science Applications International Corp., McLean, VA (USA)). Jun 1986. 152p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920362.

ASME Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components" provides rules for examination, testing, and inspection of components and systems in a nuclear power

plant. New editions of Section XI are issued every 3 years, and Addenda, which include additions and revisions to each 'Edition' of the Code, are published twice a year. This report covers ASME Section XI updates, regulatory updates and special issues such as personnel qualification and training for the period from June 1, 1984 through June 1985. Summary information is also provided on Inservice Inspection and Inservice Testing (ISI/IST) program results, plant life extension/plant aging, and repair and replacement programs. 68 refs.

37952 **NRC's experiment with plant personnel training; the acid test of self-regulation.** Reynolds, N.S. *Transactions of the American Nuclear Society;* **50**: 379-380(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

In February 1985, the US Nuclear Regulatory Commission (NRC) initiated an experiment with a form of nuclear utility self-regulation. The commissioners unanimously endorsed the nuclear utility industry's commitment to achieve self-improvement voluntarily in the area of training and qualification of nuclear plant personnel, and accepted that commitment as a basis for deferring rulemaking. In taking this action, the Commission may have signaled a marked departure from the post-Three Mile Island (TMI) era of prescriptive (and occasionally pedantic) regulatory practices to a new era of increased cooperation with nuclear utilities.

37953 **Industry self-regulation: the role of EPRI, including NSAC.** Rossin, A.D. (Electric Power Research Institute, Palo Alto, CA). *Transactions of the American Nuclear Society;* **50**: 380(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The electric utility industry created the Electric Power Institute (EPRI) in 1973 to manage research in all areas of electric energy generation, transmission, end use, and environmental impact. Each EPRI program and every EPRI project is reviewed by advisory committees made up of utility management people. This brings focus to EPRI work, and in nuclear power, it means focus on issues that have important regulatory implications. EPRI must walk a fine line to see that it does not negotiate with the US Nuclear Regulatory Commission (NRC) for any licensee or group of licensees. This cardinal principle has been strictly adhered to. However, when positions are presented to NRC, it is the licensee, owners group, or industry committee that carries the issue, with EPRI called on to provide technical information and evidence of its accuracy and quality, and how it was developed and reviewed. Outstanding examples of issues that have been treated by cooperative licensee/EPRI programs are noted.

37954 **INPO and the industry: a commitment to excellence.** Colvin, J.F. (Institute of Nuclear Power Operations, Atlanta, GA). *Transactions of the American Nuclear Society;* **50**: 380-381(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Utilities in the United States have undergone major changes in their attitudes and methods of operating nuclear stations in the 6 yr since the accident at Three Mile Island. These changes reflect a strong commitment by the US utility industry to excellence in nuclear plant operations. Fundamental in this commitment was the formation of the Institute of Nuclear Power Operations (INPO), an organization created by the industry in the United States to serve as a focus and catalyst for these changes. With membership in INPO, nuclear utilities make a commitment to strive for excellence in the construction and operation of their nuclear plants. INPO has programs to help utilities in their efforts to achieve excellence. The most visible are the INPO evaluation programs. By the end of 1985, INPO will have evaluated most operating plants at least four times. Construction project evaluations are also being conducted. Twenty-one construction evaluations will have been conducted by the end of the year. Through each of its programs, INPO seeks to promote excellence and to help those operating and building nuclear plants in their commitment to excellence.

37955 **Self-regulation: the need to succeed.** Sorenson, G.C. (Washington Public Power Supply System). *Transactions of the American Nuclear Society;* **50**: 382-383(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The nuclear industry has long complained that it is over-regulated. Others - including the regulator - are now beginning to accept this complaint and acknowledge that perhaps the industry is over regulated and something should be done to provide relief. It is clear that regulation will not simply go away. The industry is perceived by some as one that cannot be trusted and must be closely regulated or serious health and safety consequences will result. Headlines claiming coverup of design deficiencies, allegations concerning construction problems, cheating on exams, mismanagement, intimidation of QA/QC personnel, etc., do little to dispel these concerns for the layman. This paper looks at two areas that must be considered in attempting to decrease the amount of regulator-imposed activities and increase self-regulation: 1) establish greater trust and confidence in the industry's ability to do a good job and be responsible for self-regulation; and 2) establish industry initiatives to regulate itself.

37956 **Road to excellence through industry self-management.** Miller, J.H. Jr. (Georgia Power Co.). *Transactions of the American Nuclear Society;* **50**: 383(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

In March 1984, nuclear utilities in the US took the initiative to make regulations in management and people-related areas unnecessary, as such regulations would interfere with our ability to manage ourselves. Such an initiative is the Nuclear Utility Management and Human Resources Committee (NUMARC), which was formed because the authors believe the electric utility industry is best capable of managing itself. NUMARC works with the US Nuclear Regulatory Commission (NRC) and its staff to develop a new approach to improving management and people-related areas of nuclear plant operation. In a recent NRC policy statement on training and qualification, the NRC recognized that the industry, through the initiatives of NUMARC and the Institute of Nuclear Power Operations (INPO), has made progress in developing programs to improve nuclear utility training and personnel qualification. It also recognized the importance of the industry's initiative and encouraged further self-improvement. The NRC stated it will refrain from new rulemaking in the area of training for a minimum of 2 yr, while monitoring industry efforts.

37957 **Regulatory approach for nuclear plant power uprating.** Bernero, R.; Sheron, B.; Jones, R. (Nuclear Regulatory Commission, Washington, DC). *Transactions of the American Nuclear Society;* **50**: 385-386(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Nuclear power plant uprating is currently being considered by several utilities as a cost-effective means of adding generating capacity. Estimates for adding newly installed generating capacity are approximately $2250/kW(e) with experience showing in some cases twice this much. Westinghouse has estimated the costs for uprating an existing plant by 5% would only be $150/kW(e). In light of the apparent cost effectiveness of uprating nuclear power plants, it is surprising that relatively few power uprating applications have been received by the US Nuclear Regulatory Commission (NRC). It was stated that many utilities have been hesitant in pursuing power uprates because the regulatory criteria that would be applied have not been defined. This paper discusses the current NRC thinking regarding criteria that will guide our power uprating reviews. It can be expected that as more power uprating amendments are received and reviewed, these criteria could be modified based on experience.

37958 **Nuclear power plant simulation facility evaluation methodology.** Haas, P.M.; Carter, R.J.; Laughery, K.R. Jr. (Reliability and Human Factors Group, Engineering Physics and Mathematics Div., Oak Ridge National Lab., Oak Ridge, TN). pp 295-297 of Conference record for 1985 IEEE third conference on human factors and nuclear safety. Hagen, E.W. Piscataway, NJ; IEEE Service Center (1985). (CONF-8506100—).

From 3. IEEE conference on human factors and power plants; Monterey, CA, USA (23 Jun 1985).

A methodology for evaluation of nuclear power plant simulation facilities with regard to their acceptability for use in the U.S. Nuclear Regulatory Commission (NRC) operator licensing exam is described. The evaluation is based primarily on simulator fidelity, but incorporates some aspects of direct operator/trainee performance measurement. The panel presentation and paper discuss data requirements, data collection, data analysis and criteria for conclusions regarding the fidelity evaluation, and summarize the proposed use of direct performance measurement. While field testing and refinement of the methodology are recommended, this initial effort provides a firm basis for NRC to fully develop the necessary methodology.

2108 Economics

REFER ALSO TO CITATION(S) 37899, 37957, 37999, 38033, 38034, 38052, 38133

37959 **(NUREG/CR—4627) Generic cost estimates. Abstracts from generic studies for use in preparing regulatory impact analyses.** (Science and Engineering Associates, Inc., Albuquerque, NM (USA)). Jun 1986. 154p. NTIS, PC A08/MF A01 - GPO. File Number TI86901519.

The Nuclear Regulatory Commission's Cost Analysis Group (CAG) has sponsored a number of generic cost estimating studies. These studies were prepared to aid NRC analysts in preparing Regulatory Impact Analyses (RIA's). They were initiated by the CAG in order to provide costs estimates that would have wide application to a large number of Regulatory Analyses being performed throughout the NRC. These generic studies deal primarily with repair and modification activities that may be imposed on nuclear power plants as a result of regulatory actions. Abstracts of each of the generic cost estimating studies have been prepared and assembled in this catalog. These abstracts present the results of the more detailed studies in a compact, easily understood and readily usable format. Individual abstracts have been developed to treat the mainline topics of the generic studies. In addition, abstracts have been prepared covering important sub-topics or "stand-alones" which are of broad interest in RIA preparation. This abstract catalog will be expanded and modified as additional generic cost studies are completed and as abstracts are modified to reflect updated conditions.

37960 **Quality surveillance at Duke Power operating nuclear stations.** Bradley, W.H. (Duke Power). *Transactions of the American Nuclear Society;* **50**: 369-370(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Duke Power quality assurance (QA) program originally had three levels of QA audits that reported results to different levels of management and in different time frames. It soon became obvious that although problems were being identified, considerable confusion was being created by reporting them to different levels. Additionally, it was recognized that all audits were dealing in history: events that had already occurred and therefore could not be averted. What was needed was a problem identification system focused on current activities. The Duke quality surveillance program was created by dropping the first level of audits and replacing it with an on-the-scene review system to identify current problems. The quality surveillance program is a success and will be even more so after surveillance personnel acquire additional technical expertise. To that end, a training program has been initiated that will stop just short of operator licensing in the operations area and will also include other areas such as health physics and chemistry.

37961 **Engineering services to support operating nuclear power plants.** Pendergrass, M.L. (Arkansas Power and Light). *Transactions of the American Nuclear Society;* **50**: 373-374(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The utilization of contract engineering services by Arkansas Power & Light (AP & L) has significantly changed in scope over the last several months. Immediately after the Three Mile Island (TMI) incident in 1979, each utility with operational nuclear power plants suddenly needed large blocks of contractor engineering manhours to satisfy the emerging regulations. The work included the development, design, and procurement of new equipment and systems in addition to upgrading existing systems. This resulted in many multi-million dollar projects and several special issues such as Equipment Qualification and Appendix R, Fire Protection. These large projects have now been installed and most of the special regulatory issues resolved. The need for contract engineering services has shifted to the areas of equipment performance and reliability, piping analysis, and staff augmentation. With the projected lower demands for electricity and tighter budget controls, the trend for these types of engineering services is expected to continue over the next few years.

37962 **Application of nuclear analysis methods for operating plant support.** Poteralski, D.C. (Florida Power and Light Co., Miami). *Transactions of the American Nuclear Society;* **50**: 374-375(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The application of nuclear analysis methods for operating plant support is a well-established practice in the commercial nuclear power industry. The purpose of this paper is to present a management overview and describe its evolution at Florida Power & Light Company (FP & L) based on the technical issues that were faced by a specific utility. This paper also focuses on the benefits, both tangible and intangible, that are derived by a utility taking over engineering design and analysis work that has historically been performed by the fuel supplier or consultants.

37963 **AIF programs supporting industry self-improvement.** Szalay, R.A.; Bivens, A.C. (Atomic Industrial Forum). *Transactions of the American Nuclear Society;* **50**: 381-382(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Atomic Industrial Forum (AIF) report "Nuclear Power in America's Future" identifies those actions that must be taken by both government and industry if the nuclear power option is to be preserved. This includes initiatives that: 1) reduce construction costs and lead times; 2) establish a national energy policy that reflects the role of electricity and the nuclear power component; 3) provide better financial arrangements; 4) reform licensing and regulation; 5) enhance the light water reactor design; 6) inform the public on the benefits and contributions of nuclear power; and 7) complete the fuel cycle. In attempting to solve nuclear power's problems, the AIF has programs that support and push these needed actions. Much of the initiative must be taken by industry to enhance the nuclear power option. This paper discusses some AIF initiatives and programs that support industry self-improvement.

37964 **Power uprating for nuclear generating stations.** McFetridge, R.H.; Marchese, R.T. (Westinghouse Electric Corp.). *Transactions of the American Nuclear Society;* **50**: 391-392(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Thermal power uprating is a viable means to increase the electrical generation of a nuclear station in a safe and cost-effective manner. Most nuclear stations have the capability for thermal power upratings of 5 to 8% [35 to 75 MW(e)] without major hardware modifications or significant plant downtime. Within this range, an uprating program is primarily analytical in nature and consists of demonstrating continued compliance with design codes, standards, and functional requirements currently applicable to each specific plant. An uprating can be implemented in <3 yr and re-

quires a low capital investment. The estimated total cost of uprating a unit by 5 to 8% is $100 to $400/kW(e). Upratings >8% are also feasible. In general, however, significant modifications to the plant are necessary for upratings in this range (such as to the steam turbine, electrical generator, feedwater system, steam system). A number of utilities have already performed thermal power upratings. These upratings include plants designed by various nuclear steam supply system suppliers and architect/engineers, plants ranging from <500 MW(t) to >3400 MW(t), plants in various stages of design or already in operation, and both domestic and foreign plants. This broad spectrum of accomplished upratings indicates that any nuclear station can be considered as an uprating candidate at any time in its life cycle.

37965 **Application of reliability-centered maintenance to nuclear power plants.** Henry, C.D. III; Anderson, R.T. (Reliability Technology Associates). *Transactions of the American Nuclear Society;* 50: 394(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper presents the results of a Reliability Technology Associates program to structure a reliability-centered maintenance (RCM) decision logic for application to nuclear power plants. RCM is based on the following criteria: 1. Scheduled maintenance tasks should be performed on nonsafety critical components only when performance of the scheduled task will reduce the life cycle cost of ownership of the system/equipment. 2. Scheduled maintenance tasks should be performed on safety critical components only when such tasks will prevent a decrease in reliability and/or deterioration of safety to unacceptable levels or when the ask will reduce the life cycle cost of ownership of the system/equipment. RCM involves the use of a well-disciplined decision logic analysis process, which focuses on the consequences of failure to develop the most efficient and cost-effective lifetime maintenance program. The decision logic questions are automatically sequenced to those parts that are maintenance significant in a particular end item. Each significant component failure mode is evaluated to identify specific maintenance tasks. A computer-aided approach greatly facilitates use of the decision logic.

37966 **Outage inspection program.** Heishman, R.F. (Nuclear Regulatory Commission, Washington, DC). *Transactions of the American Nuclear Society;* 50: 394-397(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The NRC's Office of Inspection and Enforcement is developing a standardized inspection program for use during selected outages where work activities have a potential for adversely affecting reactor plant safety margins because of design modifications, major repairs, or component replacement. The primary objective of the program is to determine - through a sampling review and inspection process - that (a) the utility has appropriate controls for conducting design changes, modifications, and repair activities such that original safety margins are not degraded, (b) these activities are being accomplished in accordance with established procedures and commitments, (c) completed repairs and/or installations have been properly designed, inspected, and tested to assure performance of their intended function, and (d) affected systems are ready for safe startup and operation following an outage.

37967 **Concepts for reducing nuclear utility inventory carrying costs.** Graybill, R.E.; DiCola, F.E.; Solanas, C.H. (Stone and Webster Engineering Corp., Boston, MA). *Transactions of the American Nuclear Society;* 50: 415-416(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Nuclear utilities are under pressure to reduce their operating and maintenance expenses such that the total cost of generating electricity through nuclear power remains an economically attractive option. One area in which expenses may be reduced is total inventory carrying cost. The total inventory carrying cost consists of financing an inventory, managing the inventory, assuring quality, engineering of acceptable parts specifications, and procuring initial and replenishment stock. Concepts and methodology must be developed to reduce the remaining expenses of a utility's total inventory carrying cost. Currently, two concepts exist: pooled inventory management system (PIMS), originally established by General Electric Company and a group of boiling water reactor owners, and Nuclear Parts Associates' (NUPA) shared inventory management program (SIMP). Both concepts share or pool parts and components among utilities. The SIMP program objectives and technical activities are summarized.

37968 **Prudent nuclear fuel procurement: responses to legal and economic uncertainties.** Glasgow, J.A. (Doub & Muntzing, Washington, DC). *Transactions of the American Nuclear Society;* 50: 416-417(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Despite favorable developments, the following key uncertainties present difficulties for utility fuel managers: (a) whether purchases of enrichment services should be diversified between DOE and European suppliers; (b) whether DOE's progress in lowering its SWU prices will be reversed by the need to repay the US Treasury for past research and development expenditures; (c) whether antidumping trade actions may be brought by DOE or private parties against European enrichers; (d) whether the utility services (US) enrichment contract will survive a pending legal challenge; (e) whether the forces favoring privatization of the US enrichment enterprise will triumph; (f) whether DOE will find that the US uranium industry is not viable and recommend remedial actions such as limitation of imports of yellowcake; and (g) whether DOE's foreign enrichment customers will decrease their reliance on DOE, with resulting adverse impacts on DOE's program. This brief presentation reviews only a few of the important new opportunities and strategies for maximizing fuel procurement options while minimizing legal and economic risks. It appears, however, that the greatest risk in nuclear fuel procurement is failing to assess adequately the quickly changing technical, economic, and legal factors affecting the supply of feed material and enrichment services.

37969 **Backfit management: the optimal use of resources.** Berry, M.J.; Balakrishna, S. *Transactions of the American Nuclear Society;* 50: 419-420(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Nuclear utilities are seeking a rational process to determine the most efficient use of investment capital for backfit programs. Backfits can be loosely defined as any modification to plant systems, structures, or equipment and may originate from the US Nuclear Regulatory Commission (NRC), the utility, or industry standards. The provisions of the new backfitting rule require a cost assessment. To best meet this requirement, each utility should coordinate the various backfit recommendations using a systematic method rather than expending resources in an incremental fashion. The primary objective of the backfit manager is to utilize the available resources properly and to select a backfit program that attempts to achieve the objectives of the utility within specific constraints such as finances, time, manpower, radiation levels, or physical limitations. Linear programming is a viable tool to evaluate several proposed backfits simultaneously with many and varied constraints to arrive at an optimal backfit program. A simplified example of an optimization problem is shown.

37970 **Major factors impacting costs of nuclear power plants.** Tan, Z.A.; James, D.W. *Transactions of the American Nuclear Society;* 50: 422-423(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

China is striving to complete construction of 10,000 MWe of nuclear power plants by the year 2000. The Chinese government is concerned about the costs and is interested in minimizing the economic risks. The paper discusses the problems of cost control in the US and the special problems expected as China begins its nuclear power development.

37971 **Procedural system for increased management control of nuclear operations.** Frahm, R.B.; Braun, G.S. (Public Service Electric & Gas). *Transactions of the American Nuclear Society;* 50: 423-424(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Department-level administrative procedures or procedural controls have been traditionally used as a means of controlling technical activities in nuclear power generating facilities, usually prompted by operational quality assurance program criteria. More recently, procedural controls at the corporate or senior management level have emerged as utilities have developed multiple-plant facilities, reorganized their nuclear operations, and placed increased emphasis on involvement by the highest levels of management. In response to these developments, and as part of its plan to improve Nuclear Department operations, Public Service Electric & Gas Company, with assistance from Management Analysis Company, embarked on a program to develop a Vice President-Nuclear Level-Procedures manual that would clarify organization responsibilities and strengthen management control of specific activities, which would be followed by the development or revision of lower level procedures necessary to ensure department-wide compliance with the policies and requirements provided in the manual.

37972 **Improved productivity in Electricite de France nuclear power plants.** Leclercq, J. (Electricite de France). *Transactions of the American Nuclear Society;* **50**: 424(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Any reactor operator aims at ensuring the efficient management of all his generating facilities. This objective can be reflected in the following: 1) achieving satisfactory plant availability; 2) constantly matching generation to demand; and 3) reaching optimum operating costs. To assess actual records as compared to this objective, the reactor operator needs indicators such as the energy availability factor, number of outages, dosimetry, and other parameters. Added to these strictly technical indicators, Electricite de France (EdF) has recently introduced economic indicators, one for each unit and one for all of the nuclear plants. The trend in the values of these indicators demonstrates that EdF has improved its performance, particularly with regard to productivity, and ranks among the best reactor operators worldwide. Such good results rest on the organization developed in France whereby the best benefits possible are drawn from the considerable number of standardized nuclear power plants, allowing experience feedback to achieve full efficiency.

37973 **Bond to deliver our nuclear projects from bondage.** Subramanian, T.K. (Bechtel, Gaithersburg, MD). *Transactions of the American Nuclear Society;* **50**: 424(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper examines the Internal Revenue Service (IRS) ruling that prevents the use of Pollution Control Revenue Bonds (PCRB) as a source of capital to complete nuclear projects, advances arguments that prevention of pollutants should be treated at least in par with the removal, alteration, or disposal of realized pollution, recommends reexamination of the IRS ruling, and emphasizes the need for the nuclear community and ultimately the US Congress to take a fresh look at the applicability of the PCRB tax exemption incentives for the nuclear safety-related structures and systems, at least for the completion of suspended nuclear projects.

37974 **Evaluation of small reactor economics.** Braun, C. (Electric Power Research Institute, Palo Alto, CA). *Transactions of the American Nuclear Society;* **50**: 430(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The EPRI small reactor design program requires a procedure to analyze the economic benefits of specific design improvements suggested by the participating contractors, and to evaluate the total impacts of a new plant design on nuclear power generation costs. To that purpose, an analysis procedure is now being developed by EPRI and its participating contractors. This procedure involves the use of two separate costing models: 1. A top-down total generation cost model that integrates, in a relatively simplified manner, capital operating and fuel expenses, to yield total unit costs on an annual as well as on a lifetime levelized basis. A bottoms-up model that enables the analysis of specific system changes on station capital costs. Using a detailed reference plant cost breakdown, proposed design improvements can be measured against the reference data for their economic benefits.

37975 **Taipower's philosophy and practices for management of its nuclear power development program.** Chu, D.S.L. (Taipower, Taiwan). *Transactions of the American Nuclear Society;* **50**: 483-484(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Taipower has been considered successful in nuclear power development and utilization in recent years. This paper presents Taipower's philosophy and practices in managing its nuclear power program with respect to management participation, personnel training, planning, design and construction, operation and maintenance, and the fuel cycle.

37976 **Search for excellence: a progress report from the Tokyo Electric Power Company.** Hori, I. (Tokyo Electric Power Company, Japan). *Transactions of the American Nuclear Society;* **50**: 489-490(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The current situation of nuclear power generation in Japan, the history of the development of nuclear power technologies, and characteristic features of nuclear power development in Japan from the point of view of management and its efforts are discussed in the paper. Plans are to continue to promote the establishment of a nuclear fuel cycle in Japan, to establish plutonium utilization technology and prepare conditions for commercial use of plutonium, and to develop technology for the commercialization of the fast breeder reactor, all for the purpose of improving technology and increasing the economic competitiveness of nuclear power as a total system.

37977 **Search for excellence: a progress report from the Swedish State Power Board.** Gustafsson, L. (Swedish State Power Board). *Transactions of the American Nuclear Society;* **50**: 490-491(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

By international comparison, the availabilities of Swedish nuclear units are fairly high, and nuclear power generation is considered successful. Some of the factors that contribute to this success are management by objectives, functional administrative and information systems, reactor maintenance management, improvements in steam generator performance, successful fuel management, good nuclear safety records, research and development programs, and responsible radioactive waste management.

37978 **Managerial challenges in nuclear training.** Scholand, G.W. (Westinghouse Electric Corp., Zion, IL). *Transactions of the American Nuclear Society;* **50**: 510-511(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Nuclear personnel training programs have existed since the infancy of the commercial nuclear power industry. The scope and complexity of these programs have increased dramatically, especially since the Three Mile Island mishap in 1979. Whether voluntary or regulated, the changes of the past several years have greatly increased the responsibilities and roles of the nuclear training managers. Events and our own diligence have compounded two problems (or challenges) that have been with us all along. First, training managers have frequently been excluded from the change-making process, leaving them to react as best they can to new regulatory mandates and new utility innovations in a de facto fashion. Second, the additional resources needed to meet new requirements (personnel, equipment, facilities, and funds) have not been made available, or have been insufficient to accomplish new tasks. This paper discusses these challenges and considers several responses (including a national nuclear trainers association) that can go a long way to place nuclear training managers and their employees more in control of their own fate.

37979 **Improved operation using the fixed margin technical specification system.** Cheng, A.Y.; Kochendarfer, R.A.; Rombough, C.T. (Babcock & Wilcox Co.). *Transactions of the American Nuclear Society;* **50**: 522-524(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The limiting conditions for operation technical specifications preserve the initial condition assumptions of the final safety analysis report accident analyses (loss-of-coolant accident, pre-accident departure from nucleate boiling, etc.). Currently, global parameters such as offset and tilt are monitored to ensure indirectly that the limiting criteria have not been exceeded. Such indirect monitoring imposes unnecessarily restrictive operating limits. The Fixed Margin Technical Specification System (called FMTS) uses a fixed in-core detector system to monitor directly the margin to the limiting criteria. The system substantially broadens the allowable operating window by statistically combining the individual uncertainties of the measurement system and removing the conservatism inherent in using global parameter monitoring. In addition, FMTS uses a CRT to visually display the proximity to the limiting criteria in terms of such parameters as power level and rod position. Such displays also help the operator determine the direction of control on these parameters and unnecessary trips.

37980 **Compact analyzer: an interactive simulator.** Ipakchi, A.; Khadem, M.; Colley, R.W. (EPRI, Palo Alto, CA). *Transactions of the American Nuclear Society;* **50**: 529-530(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Compact Analyzer is a computer system that combines dynamic simulation models with interactive and color graphics user interface functions to provide a cost-effective simulator for dynamic analysis and evaluation of power plant operation, with engineering and training applications. Most dynamic simulation packages such as RETRAN and TRAC are designed for a batch-mode operation. With advancements in computer technology and man/machine interface capabilities, it is possible to integrate such codes with interactive and graphic functions into advanced simulators. The US Nuclear Regulatory Commission has sponsored development of plant analyzers with such characteristics. The Compact Analyzer is an Electric Power Research Institute (EPRI)-sponsored project, which currently utilizes the EPRI modular modeling system (MMS) for process simulation, and uses an adaptable color graphic package for dynamic display of the simulation results.

2109 Process Heat Reactors

37981 **(Juel—2023) Hydrogen- and tritium permeation within high temperature reactor (HTR) development. Results for the alloy Hastelloy X.** Buchkremer, H.P.; Diehl, W.; Jonas, H.; Mallener, W.; Stoever, D.; Luthardt, G.; Muehlratzer, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.); Maschinenfabrik Augsburg-Nuernberg (M.A.N.) A.G., Muenchen (Germany, F.R.). Bereich Neue Technologie). Nov 1985. 87p. (In German). NTIS, PC E09; Available from NTIS as TIB/B86-05304.

It is reported about important results for practical application of hydrogen/tritium permeation through the alloy Hastelloy X. Permeation data dependent on temperature and pressure have been generated and are presented as well for bright as oxide coated alloy specimen. Moreover the results of systematic preoxidation studies are presented by comparing them with corresponding "in situ" values. (orig.).

37982 **Dynamic responses of fuel and target assemblies of a production reactor.** Crowley, D.A.; Yau, Wenfoo. (Du Pont de Nemours, E.I. and Co., Aiken, SC, USA. Savannah River Lab.). *Res Mechanica;* **17**: No. 1, 1-10(1986).

As part of the qualification research aimed at assuring safe operation of the production reactors at the Savannah River Plant, the dynamic responses of internal reactor components are being analyzed. One such program investigates the responses of heavy fuel and target assemblies undergoing two types of loadings -the disturbances due to the motion of machines that transport the assemblies to and from the reactor, and the seismic loading due to a design basis earthquake during reactor operation. This qualification research is supported by an experimental program to verify the analytical predictions. The assemblies under consideration are composed of 18 pairs of cylindrical 'slugs' which are stacked up along, and supported by, a slender aluminium-6063 alloy housing. The housing consists of a tube with radial ribs to maintain a standoff distance from the slugs, and end fittings which are designed to facilitate assembly handling. The fuel and target assemblies weigh 500 and 750 lbf, respectively, and are 185 in. long. The assemblies are modeled as a uniform tube with time-dependent boundary conditions which are chosen to simulate the dynamic loadings. The method of analysis is discussed. Results are presented.

22 NUCLEAR REACTOR TECHNOLOGY

REFER ALSO TO CITATION(S) 37953

37983 **(NE—01-86-KWIC-INDEX) Nuclear energy standards. KWIC index.** (USDOE Assistant Secretary for Nuclear Energy, Washington, DC). Jan 1986. Contract AC05-84OR21400. 46p. Performance Assurance Project Office P.O. Box Y, Oak Ridge, TN 37831. File Number TI86012642.

The KWIC Index is an alphabetical listing that provides rapid identification of NE standards based upon the specific subject areas. This index facilitates identification of a NE standard by major or key works located in the center of the alphabetical index listing (# indicated the beginning of a particular title, and * indicated the end). Alphanumerical designations for specific NE standards are shown in the right-hand column. Standards referenced in this listing include those that are active, inactive, or discontinued.

37984 **(NE—07-86-Master-Index) Nuclear Standards master index.** (Oak Ridge National Lab., TN (USA)). 1 Jul 1986. Contract AC05-84OR21400. 54p. PAPO, ORNL, Building 9204-1, Rm. 321, PO Box Y, Oak Ridge, TN 37831. File Number TI86012476.

This index provides a complete list, organized by standard numbers, of all assigned NE numbers, their title, issue date, amendment number and date, issue date of the superseded standard if any, standards writer/cognizant engineer, DOE/cognizant engineer, and a remarks column which reflects the current status of the standard.

2201 Theory And Calculation

37985 **(AD-A—165738/6/XAB) Existence of minimum critical mass solutions for diffusion equations of reactor theory.** (Wisconsin Univ., Madison (USA). Mathematics Research Center). 1985. 14p. NTIS, PC A02/MF A01.

This is a mathematical formulation of the minimum critical mass problem for thermal nuclear reactors, in the multi-group diffusion approximation assuming an extrapolated boundary and making cascade assumptions. The measure sigma is the nuclear fuel density and phi sub o,..., phi sub m are the densities of neutrons, grouped in m+ 1 levels of increasing kinetic energy. The main result is the proof of existence of an optimal solution when the operator K is symmetric on H_0^1 (omega) and there is a sufficiently high number of energy levels, namely m + 1> n/2, provided the cometing set is nonvoid. Further it is shown that any optical fuel density has compact support in omega provided the L sub i have sufficiently smooth coefficients.

37986 **Solution of the two-dimensional space-time reactor kinetics equation by a locally one-dimensional method.** Chen, G.S.; Christenson, J.M. (Univ. of Cincinnati, OH). *Transactions of the American Nuclear Society;* **50**: 536-537(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

In this paper, the authors present some initial results from an investigation of the application of a locally one-dimensional (LOD)

finite difference method to the solution of the two-dimensional, two-group reactor kinetics equations. Although the LOD method is relatively well known, it apparently has not been previously applied to the space-time kinetics equations. In this investigation, the LOD results were benchmarked against similar computational results (using the same computing environment, the same programming structure, and the same sample problems) obtained by the TWIGL program. For all of the problems considered, the LOD method provided accurate results in one-half to one-eight of the time required by the TWIGL program.

37987 Theoretical method of power overshoot evaluation for nodal reactor models. Pinheiro, M.; Pocamora, F.; Podowski, M.Z. (Rensselaer Polytechnic Institute, Troy, NY). *Transactions of the American Nuclear Society;* **50**: 538-539(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

An analytical method of evaluating the power overshoot for nonlinear space-dependent (nodal) reactor models has been introduced. This method provides a convenient tool for obtaining accurate estimates of the reactor peak power, including its spatial distribution, without explicitly solving differential equations of reactor dynamics.

37988 Static three-dimensional ARROTTA benchmarking. Eisenhart, L.D.; Eich, W.J.; Mosteller, R.D. (S. Levy, Inc., Campbell, CA). *Transactions of the American Nuclear Society;* **50**: 540-542(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

ARROTTA (Advanced Reactor Rapid Operational TransienT Analyzer) is a three-dimensional analytic nodal diffusion theory computer code. It has been developed for spatial kinetics applications and was sponsored by the Electric Power Research Institute (EPRI). The results presented here are part of the benchmarking and validation of the ARROTTA steady-state initializer and its associated numerical methodology. These results demonstrate the accuracy and efficiency of the ARROTTA steady-stage initializer for a variety of benchmarks, including a three-dimensional problem with full thermal-hydraulic feedback.

37989 Extended bias-factor data transposition method. Gandini, A. (ENEA - Italy). *Transactions of the American Nuclear Society;* **50**: 547-548(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The importance of experimental campaigns in relation to the design of a specific reference project is well recognized. In these cases, a number of quantities, significant with respect to the major integral parameters relevant to the reference system are measured in an experimental facility (in particular, physical and/or engineering mock-up), and then transposed to the reference system itself. In cases in which the experimental facility is very similar, only minor corrections are generally necessary and the simple, well known, bias-factor transposition (BFT) method can be successfully adopted. But if the two systems differ to some extent and/or if quantities in the experimental facility somehow differ from those of the reference design are considered, although the useful information contained in the measurements remains significant, making full use of it may become a problem. An extension of the simple BFT method is then proposed, so that full use of the available experimental information can be made. This extended methodology can be used as well for optimal experimental planning in view of specific design objectives.

37990 Approximate solution for the reactor neutron probability distribution. Ruby, L.; McSwine, T.L. (Univ. of California, Berkeley). *Transactions of the American Nuclear Society;* **50**: 549(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Several authors have studied the Kolmogorov equation for a fission-driven chain-reacting system, written in terms of the generating function G(x,y,z,t) where x, y, and z are dummy variables referring to the neutron, delayed neutron precursor, and detector-count populations, n, m, and c, respectively. Pal and Zolotukhin and Mogil'ner have shown that if delayed neutrons are neglected, the solution is approximately negative binomial for the neutron population. Wang and Ruby have shown that if the detector effect is neglected, the solution, including the effect of delayed neutrons, is approximately negative binomial. All of the authors assumed prompt-neutron emission not exceeding two neutrons per fission. An approximate method of separating the detector effect from the statistics of the neutron and precursor populations has been proposed by Ruby. In this weak-coupling limit, it is assumed that $G(x,y,z,t) = H(x,y)I(z,t)$. Substitution of this assumption into the Kolmogorov equation separates the latter into two equations, one for H(x,y) and the other for I(z,t). Solution of the latter then gives a generating function, which indicates that in the weak-coupling limit, the detector counts are Poisson distributed. Ruby also showed that if the detector effect is neglected in the equation for H(x,y), i.e., the detector efficiency is set to zero, then the resulting equation is identical with that considered by Wang and Ruby. The authors present here an approximate solution for H(x,y) that does not set the detector efficiency to zero.

37991 Quasi-analytic point reactor kinetics calculations using individual precursor data. Brady, M.C.; Perry, R.T.; Wilson, W.B.; England, T.R. (Texas A & M, College Station). *Transactions of the American Nuclear Society;* **50**: 549-550(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

It has become an industry standard to use the classic six-group delayed neutron representation in reactor kinetics calculations. The purpose of this work is to modify the point reactor kinetics equations to consider each of the 105 precursors explicitly, and compare the results for simple step changes in reactivity (e.g., as in control rod calibration curves) using 105 precursors to the six-group results using ENDF/B-V data. The results using the explicit nuclide representation are significantly different than the six-group scheme and thus could impact design and operating reactor reactivity evaluations for all fuels.

37992 Analytic solution to the time-dependent first-daughter fission-product plateout problem for multi-region isothermal slug flow. Durkee, J.W. Jr.; Lee, C.E. (Los Alamos National Lab., NM, USA; Texas A and M Univ., College Station, USA. Dept. of Nuclear Engineering). *Annals of Nuclear Energy;* No. 6, 273-289(1985).

The time-dependent, axisymmetric, isothermal slug flow convective-diffusion equation with radioactive decay is solved analytically to predict the behavior of a first-daughter fission-product undergoing gaseous transport through multiple materials in a cylindrical pipe. The integration coefficients are determined using the Davidon variable metric minimization method. The behavior of fission-product material deposited on the conduit wall is described by a standard mass-transfer model. The time-dependent plateout rate behavior, determined previously for parent fission-product deposition, is again evident for daughter product plateout. Dominance of the daughter plateout by parent deposition characteristics is apparent. The determination of the daughter wall mass-transfer and diffusion coefficient using a least-squares analysis of measured data depends upon a reasonably low ratio of parent/daughter half-lives. This is illustrated with $^{137}Ca/^{137}Ba(=2 \times 10^{5})$ and $^{140}Ba/^{140}La(=7.6)$, where for $^{137}Ca/^{137}Ba$ the solution sensitivity to the ^{137}Ba deposition parameters is small and for $^{140}Ba/^{140}La$ a reasonable solution is readily obtained.

2202 Components And Accessories

REFER ALSO TO CITATION(S) 37979, 38005, 38031, 38253

37993 (BNL-NUREG—38048) Soil-structure interaction effects on the reliability evaluation of reactor containments. Pires, J.; Hwang, H.; Reich, M. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 11p. (CONF-860816—1). NTIS, PC A02/MF A01 - GPO. File Number TI86011198.

From 3. U.S. national conference on earthquake engineering; Charleston, SC, USA (24 Aug 1986).

The probability-based method for the seismic reliability assessment of nuclear structures, which has been developed at Brookhaven National Laboratory (BNL), is extended to include the effects of soil-structure interaction. A reinforced concrete containment building is analyzed in order to examine soil-structure interaction effects on: (1) structural fragilities; (2) floor response spectra statistics; and (3) correlation coefficients for total acceleration responses at specified structural locations.

37904 **(EPRI-NP—4582) Study of microbiologically influenced corrosion in nuclear power plants and a practical guide for countermeasures. Final report.** Pope, D.H. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Biology). May 1986. 83p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920316.

A summary of the occurrences of microbiologically influenced corrosion in the nuclear power industry is presented. This shows that MIC is a problem in most, if not all, systems and alloys (except titanium) used in the industry. It is also concluded that the cases of MIC seen thus far are only the "tip of the iceberg." Case histories are presented giving available details of the appearance of MIC of various alloys in a variety of systems. Strategies for the detection of MIC are presented, including new methods designed for use by field personnel which employ immunochemicals linked to enzymes or fluorescent dyes. Prevention and treatment methods including the use of pH modification, borate, ozone, hydrogen peroxide, penetrating oils, chlorine, and film forming corrosion inhibitors are discussed. A field guide and a step by step procedure for the investigation of MIC by field personnel are also provided.

37905 **(EPRI-NP—4622) Stress corrosion characterization of turbine rotor materials. Phase 2. Final report.** (Metal Properties Council, Inc., New York (USA)). Jun 1986. 64p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920341.

This report describes the second phase of a research program to identify the conditions of temperature, solution composition and stress sufficient to cause stress corrosion cracking of quenched and tempered 3.5 NiCrMoV steels used in low-pressure (LP) rotors of power plants. Slow-strain-rate tests were conducted on samples from two 3.5 NiCrMoV forgings over a temperature range of 93 to 157°C (200 to 315°F) in three potential LP turbine environments - water, NaCl solutions, and dilute caustic-chloride solutions. The effect of oxygen also was investigated. A limited number of constant-load tests were conducted in 10% NaOH solutions and in a dilute caustic-chloride solution. Results indicate cracking occurs under specific conditions of temperature and potential. Transgranular cracking occurred in chloride solutions and in oxygenated water. Cracking in dilute caustic-chloride solutions was both transgranular and intergranular. Results of constant-load tests were found to depend upon procedures followed in establishing tests conditions. An evaluation of the slow strain rate results in terms of potential-pH diagrams was performed.

37906 **(EPRI-NP—4626) Steam generator tube sampling: feasibility study. Final report.** Stafford, D.K. (Babcock and Wilcox Co., Lynchburg, VA (USA). Contract Research Div.). Jun 1986. 273p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920363.

This contract between the Electric Power Research Institute and The Babcock and Wilcox Company (contract S-304-2) was for the purpose of demonstrating the feasibility of remotely removing coupons from within nuclear steam generator tubes for subsequent metallurgical and chemical analysis of an undisturbed portion. This contract was initiated due to the problem being experienced with tube failure and the need for evaluation of the cause of failure. The approach taken was to evaluate cutting methods and select one or more of those available that were most amenable to remotely removing coupons with minimum disturbance to metallurgical and chemical properties with suitable reliability, controllability, and speed. The results based on extensive experimental tests with both electro-discharge machining (EDM) and metal disintegration machining (MDM) indicated coupons can be removed under the requirements above. Areas requiring further design investigation to assure reliable field deployment were identified. It was concluded that removing coupons from within nuclear steam generator tubes is feasible based on the demonstrations accomplished. It is believed that the required further design investigations can be successfully implemented, and therefore it is recommended that continued development be funded to design, construct, and demonstrate a field-worthy system for removing the desired test coupons. 26 figs.

37907 **(EPRI-NP—4627) Stress relief cracking in nuclear pressure vessel steels. Final report.** McMahon, C.J. Jr.; Gentner, D.H. (Pennsylvania Univ., Philadelphia (USA). Dept. of Materials Science and Engineering). Jun 1986. 52p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920335.

Specimens from 33 heats of three types of nuclear pressure vessel steel were heat treated to produce a simulated weld HAZ microstructure and tested to determine their resistance to stress relief cracking (SRC). The method employed a special jig in which notched specimens were loaded in 3-point bending to a fixed displacement and then heated to 610°C for 6 h in a simulated stress relief treatment. The susceptibility to SRC was measured in terms of the extent of cracking as a function of the notch-opening displacement. The results showed that the forging grade A508-2 was generically much more susceptible to SRC than either the plate grade A533-B or the forging grade A508-3. The four tested heats of the latter steel showed almost no SRC susceptibility within the limitations of these tests. In the other two steels wide heat-to-heat variation in SRC susceptibility was found. 20 refs., 24 figs.

37908 **(NUREG/CR—4588-Vol.3) Soil-structure interaction. Volume 3. Influence of ground water.** Costantino, C.J. (City Univ. of New York, NY (USA); Brookhaven National Lab., Upton, NY (USA)). Apr 1986. Contract AC02-76CH00016. 83p. (BNL-NUREG—51983-Vol.3). NTIS, PC A05/MF A01 - GPO. File Number TI86011100.

This report, Volume 3 of the report, presents a summary of the first year's effort on the subject of the influence of foundation ground water on the SSI phenomenon. A finite element computer program was developed for the two-phased formulation of the combined soil-water problem. This formulation is based on the Biot dynamic equations of motion for both the solid and fluid phases of a typical soil. Frequency dependent interaction coefficients were generated for the two-dimensional plane problem of a rigid surface footing moving against a saturated linear soil. The results indicate that interaction coefficients are significantly modified as compared to the comparable values for a dry soil, particularly for the rocking mode of response. Calculations were made to study the impact of the modified interaction coefficients on the response of a typical nuclear reactor building. The amplification factors for a stick model placed atop a dry and saturated soil were computed. It was found that pore water caused the rocking response to decrease and translatinal response to increase over the frequency range of interest, as compared to the response on dry soil. 56 refs., 31 figs.

37909 **Steam generator nozzle dam system.** Zezza, L.J. *Transactions of the American Nuclear Society;* **50**: 412-413(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Many utilities are utilizing steam generator nozzle dams inside their steam generators to permit refueling and eddy-current testing or repair of steam generator tubes to occur simultaneously. Prior to consideration of this application, steam generator nozzles did not have any means to positively hold such dams in place. However, some of the current steam generator nozzles are supplied with flange rings to facilitate sealing of the nozzles in a positive manner with a blind flange seal. A variety of techniques can be used to dam the steam generator nozzles, although many of these approaches have significant disadvantages. Various concepts have been evaluated for installing steam generator nozzle dams and a design has been developed that eliminates these disadvantages. The design is compatible with steam generator nozzles with flange rings. The nozzle dam system described herein has been installed successfully at several nuclear power plants, holding back a 35-ft head of water with no leakage. Its application has resulted in a significant reduction of critical path time and man-rem exposure.

38000 Integrating environmental qualification requirements into normal plant operations. Abelea, J.M. *Transactions of the American Nuclear Society;* **50**: 518-519(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

In 1979 when formal environmental qualification (EQ) requirements for electrical equipment in nuclear power stations were first published, the utility industry approached the requirements as a licensing issue. In March 1985, the requirements now embodied in 10CFR50.49 went into force. Concurrently, the US Nuclear Regulatory Commission (NRC) is testing an EQ inspection module, which will be used by regional personnel in licensee inspections. This paper discusses the interfaces and operational areas for an idealized EQ program. The paper is based on the results of industry audits, current regulatory interpretation, and regulatory inspections. A fully functional EQ program impacts qualification package maintenance, training surveillance and maintenance, procurement, and licensing. Utilities have formulated programs to meet EQ requirements based on the premise that each department could act discretely to fulfill its assigned function. Implementation of EQ requirements is optimized when a single organization or individual is responsible for the program because the responsible party assures that interfaces are established, efforts are coordinated, and communication is encouraged.

38001 Current capabilities for continuous as monitoring to detect flaws in reactor pressure boundaries. Hutton, P.H. Kurtz, R.J. (Pacific Northwest Lab., Richland, WA). pp 217-222 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-1. Residual-life assessment, nondestructive examination, and nuclear heat exchanger materials. Jaske, C.E. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—).

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

The objective of the work described is to develop and validate the use of acoustic emission (AE) methods for continuous surveillance of flaw growth in reactor pressure boundaries. This will provide the benefit of helping to continuously assure physical integrity of reactor pressure boundaries. This paper discusses results obtained to date in terms of AE monitoring technology available for application now and further capability presently under development.

38002 A simplified model for computing pipe to pipe impact response. Friley, J.R. (Pacific Northwest Lab., Richland, WA). pp 15-20 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-6. Structural dynamics. Chen, S.S. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—).

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

A simplified method has been devised to assess the responses of pipe to pipe impact events for a limited set of conditions. The impacted pipe is required to be straight, simply supported, fluid filled and struck at its mid span. The impacting pipe is required to be straight and pivoted about a fixed end. Plastic hinge locations are limited to the points of contact. The pipes are assumed to remain in contact and not rebound. Thus all of the initial kinetic energy is assumed to be dissipated either by local pipe crushing or by plastic hinge motion. The model shows reasonable agreement with experimental results.

38003 Identification of G-phase in aged cast CF 8 type stainless steel. Bentley, J.; Miller, M.K.; Brenner, S.S.; Spitznagel, J.A. (Oak Ridge National Lab., TN). *Proceedings - Annual Meeting, Electron Microscopy Society of America;* **43**: 328-329(1985). Contract AC05-84OR21400.

The microstructure of as-cast and aged CF 8 type stainless steel, used for the primary coolant pipes in pressurized light-water nuclear reactors, is being studied by analytical electron microscopy (AEM) and atom probe field-ion microscopy (APFIM). The phase transformations of the ferrite (~ 19 vol % of the duplex structure) that occur after aging at 673 K for 7500 h are described by Miller et al. The present work deals with the identification of G-phase (prototype compound $Ni_{16}Ti_6Si_7$) observed in the ferrite of aged material. 2 references, 3 figures.

2204 Control Systems

38004 Role of electronic reliability in reactor scram frequency reduction. Mayo, C.W.; Shugars, H.G. (SAIC, Oak Ridge, TN). *Transactions of the American Nuclear Society;* **50**: 507-508(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Over 1200 nuclear plant outages totaling 34 169 lost production hours were associated with instrument, control, and electrical device problems from 1980 through 1982. Internal component failure was the major cause category, representing 45% of the forced outage duration. The major equipment category was electronic module and power supply drift and component failure, representing 15% of this outage time. As a result of these findings, the Electric Power Research Institute initiated a research project to identify and evaluate ways to improve the reliability of power plant instrument and control electronics. Specific practices included: 1) circuit design (e.g., numbers and types of components used); 2) component selection; and 3) module testing. Results show that reliability and drift performance can be improved by a factor of 10 or more. When applied, these improvements can substantially reduce the number of reactor scrams due to electronic equipment failure. The project's methodology and specific findings are described.

38005 An automated aid for isolating defects in the heat exchanger tubing of nuclear steam generators. Cleveland, D.; O'Brien, L.J.; Wereley, M. (Greenbriar Systems, Inc., Vienna, Virginia). pp 193-208 of Energy conservation technology and methods seminar - 1985. Research Triangle Park, NC; Instrument Society of America (1984). (CONF-841122—).

From Symposium on new technologies in nuclear power plant instrumentation and control; Washington, DC, USA (28 Nov 1984).

The inspection of heat exchanger tubing in nuclear power plants, for purposes of detecting, classifying and quantifying defects, is presently accomplished manually by visual analysis of eddy current waveform data. The procedure is time consuming, costly and subject to human error. The objective of this study was to demonstrate the feasibility of using software as an automated aid in the detection of anomalous eddy current waveforms. Due to the difficulty of detecting defects in the presence of the support plate signals, the study concentrated on the detection of defects in the support plate regions of the heat exchanger tubing. The key purpose of the automated aid is to eliminate normal support plate response (SPRs) from the inspector's visual consideration. Thus, the purpose of the algorithm is to detect normal SPRs and dismiss them from the inspector's visual inspection. Conversely, the algorithm flags any anomalous waveform, whether the anomaly represents a defect or a benign phenomenon such as probe wobble. The inspector is still the decision-maker with regard to whether the anomalous SPR represents a defect or a benign event. A database of simulated pits of varying depth, diameter, and volume was obtained by pulling an eddy current probe through a once-through steam generator (OTSG) mock-up. The discriminator was successful in eliminating over 80% of the normal SPRs from the analyst's consideration. A the same time, almost all of the defects with a volume greater than 30,000 mils cubed or a depth greater than 10 mils were labelled anomalous and flagged for analyst interpretation. The authors conclude that this research demonstrates the feasibility of automated aids for the isolation of areas in steam tubes which may contain defects. An instrument that implements such an aid would reduce the time required to perform the general defect detection survey by approximately 75%. J

2205 Environmental Aspects

REFER ALSO TO CITATION(S) 37973, 38443, 38991

2206 Research, Test, And Experimental Reactors

REFER ALSO TO CITATION(S) 37982

38006 (NBS/SP—711, pp 11-15) **NBS cold neutron research facility.** Rowe, J.M. (National Bureau of Standards, Gaithersburg, MD). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

A large-volume heavy-ice cold moderator to be operated at 25K is being tested for insertion into a reserved space in the reactor early in 1986. This moderator will provide a large increase in available cold neutron ($\lambda > 4$ A) flux, and can provide access for large number of neutron guide tubes. NBS has proposed the construction of a large (240' x 130') experimental hall and associated instrumentation, which would be operated as a national facility. The NBS proposal includes funding for 11 experimental facilities, and reserves space for an additional 5 facilities to be developed by Participating Research Teams (PRT's). For the NBS developed stations, 2/3 of the available time would be reserved for use by the general US scientific community (to be scheduled by a Program Advisory Committee), with the remaining time reserved to NBS and collaborators. 4 refs., 3 figs.

38007 (NBS/SP—711, pp 16-24) **Cold and ultra cold neutron beams for fundamental physics research at the Institute Laue-Langevin.** Ageron, P.; Mampe, W. (Institute Laue-Langevin, Grenoble, France). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

All experiments discussed at this workshop need intense beams of low energy neutrons with low gamma ray and fast neutron backgrounds. The High Flux Reactor of the ILL, Grenoble, offers in connection with the integrated cold and ultra-cold sources, a large variety of those facilities. The beams, transported in neutron guides, cover the whole wavelength range from one Angstrom to several thousand Angstroms. 9 refs., 8 figs.

38008 **(ORNL/M—110) National Low-Temperature Neutron Irradiation Facility (NLTNIF). The status of development.** Coltman, R.R. Jr.; Kerchner, H.R.; Klabunde, C.E.; Young, F.W. Jr. (Oak Ridge National Lab., TN (USA)). Dec 1985. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012310.

In May 1983, the Department of Energy authorized the establishment of a National Low-Temperature Neutron Irradiation Facility (NLTNIF) at ORNL's Bulk Shielding Reactor (BSR). The NLTNIF, which will be available for qualified experiments at no cost to users, will provide a combination of high radiation intensities and special environmental and testing conditions that have not been previously available in the US. Since the DOE authorization, work has proceeded on the design and construction of the new facility without interruption. This report describes the present status of the development of the NLTNIF and the anticipated schedule for completion and performance testing. There is a table of the major specifications and capabilities and a schematic layout of the irradiation cryostate for design and dimensioning of test and experiment assemblies.

38009 **Function of university reactors in operator licensing training for nuclear utilities.** Wicks, F. (Rensselaer Polytechnic Institute, Troy, NY). *Transactions of the American Nuclear Society;* **50**: 401-402(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The director of the Division of the US Nuclear Regulatory Commission in generic letter 84-10, dated April 26, 1984, spoke the requirement that applicants for senior reactor operator licenses for power reactors shall have performed then reactor startups. Simulator startups were not acknowledged. Startups performed on a university reactor are acceptable. The content and results of a five-day program combining instruction and experiments with the Rensselaer reactor are summarized.

38010 **UCLA research reactor relicensing, or guilty until proven innocent.** Wegst, W.F. (Univ. of California, Los Angeles). *Transactions of the American Nuclear Society;* **50**: 403-404(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper briefly reviews the history and experiences of the University of California, Los Angeles (UCLA) in attempting to relicense its 100-kW Argonaut research reactor. The process of intervention in US Nuclear Regulatory Commission (NRC) licensing hearings is briefly reviewed. The intervention in the UCLA case, by an antinuclear group called the Committee to Bridge the Gap (CBG), is described. The outcome of the entire proceeding is summarized and opinions are presented on the validity and viability of the licensing/intervention process.

38011 **Man/machine interface algorithm for advanced delayed-neutron signal characterization system.** Gross, K.C. (Argonne National Lab., IL). *Transactions of the American Nuclear Society;* **50**: 519-520(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The present failed-element rupture detector (FERD) at Experimental Breeder Reactor II (EBR-II) consists of a single bank of delayed-neutron (DN) detectors at a fixed transit time from the core. Plans are currently under way to upgrade the FERD in 1986 and provide advanced DN signal characterization capability that is embodied in an equivalent-recoil-area (ERA) meter. The new configuration will make available to the operator a wealth of quantitative diagnostic information related to the condition and dynamic evolution of a fuel breach. The diagnostic parameters will include a continuous reading of the ERA value for the breach; the transit time, T/sub tr/, for DN emitters traveling from the core to the FERD; and the isotopic holdup time, T/sub h/, for the source. To enhance the processing, interpretation, and display of these parameters to the reactor operator, a man/machine interface (MMI) algorithm has been developed to run in the background on EBR-II's data acquisition system (DAS). The purpose of this paper is to describe the features and implementation of this newly developed MMI algorithm.

38012 **New calculational method for the sensitivity coefficient in a cell.** Takeda, T.; Nakano, M. (Osaka Univ., Japan). *Transactions of the American Nuclear Society;* **50**: 545-547(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The authors have developed a new calculational method for the sensitivity coefficients of cell parameters based on generalized perturbation theory. To consider the heterogeneity in a cell accurately, the collision probability is used. The method is described, and results of applications to the tight-pitch cell of the Proteus reactor are presented. Such results are useful in investigating the effect of cross sections on cell parameters.

38013 **Breached fuel location in FFTF by delayed neutron monitor triangulation.** Bunch, W.L.; Tang, E.L. (Westinghouse Hanford Co., Richland, WA). *Transactions of the American Nuclear Society;* **50**: 571-572(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The purpose of this work was to develop and evaluate a method of locating breached fuel within the Fast Flux Test Facility (FFTF) reactor based on the relative response of the delayed neutron monitors (DNM) located on each of the three primary sodium cooling loops. The primary method of location is the use of tag gas containing unique ratios of the noble gases xenon and krypton. Although the tag gas system works quite well, it is relatively expensive because of the costs of preparing and loading the gas into each

fuel pin. Triangulation of DNM signals could potentially decrease tag gas costs while maintaining overall location reliability.

2207 Plutonium And Isotope Production Reactors

38014 Calculational tracking of decay heat for FFTF assemblies. Carter, L.L.; Cillan, T.F. (Westinghouse Hanford Co., Richland, WA). *Transactions of the American Nuclear Society;* **50**: 410-411(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Fast Flux Test Facility is designed for the irradiation testing of nuclear reactor fuels and materials required for the development of commercial fast breeder power reactors. The decay heat rate associated with components irradiated in the test reactor is an important parameter in establishing processing schedules throughout the facility. That is, the facilities and equipment used to transport, process, examine, and store the irradiated components have explicit heat removal capabilities that should not be exceeded. Also, operation of some handling and processing equipment requires prior knowledge of the decay heat rate in order for correct operating parameters to be established in advance. To accommodate these operational requirements, a user friendly computerized system has been developed to calculate the decay heat rate associated with any given assembly or any defined set of assemblies. The data base for this system can be updated at the end of any operating period to provide actual decay heat rates, or future data bases can be generated using forecasted operating histories to provide information for planning future movement of irradiated components within the facility.

38015 Examination and replacement of electromagnetic pumps from FFTF primary circuits. Young, M.W.; Brehm, W.F.; Lutton, J.M.; Grygiel, M.L.; McCargar, C.G. (Westinghouse Hanford Co., Richland, WA). *Transactions of the American Nuclear Society;* **50**: 411-412(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

On November 16, 1984, a leak was discovered in the Fast Flux Test Facility (FFTF) primary sodium sampling system. The leak occurred in one of two parallel electromagnetic (EM) pumps designed to take suction from the primary system drain tank and pump sodium through the cold trap to maintain coolant purity. The purpose of this paper is to describe the examination of the pump after its removal from the circuit, define the apparent cause of the leak, and give the applications of the examination to future plant operations.

2208 Propulsion Reactors

REFER ALSO TO CITATION(S) 37769

38016 Laser innovation: wallet-sized exposure history, training record, and identification. Stroupe, E.P. *Transactions of the American Nuclear Society;* **50**: 509-510(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The science of lasers as used in video disks and audio compact disks has made possible very high capacity data storage. A wallet-sized card has been developed, which has a storage capacity of 1 megabyte - ~800 typewritten pages of information. The data stored can be either machine readable or eye-readable information including photos, signatures, text, graphs, or x-rays. This technology coupled with user-friendly software, an IBM or compatible personal computer, and an optical read/write unit has made it possible to have a credit card size personal file that can be updated instantly. It is possible to have an identification card, an up-to-date complete radiation exposure history, and a training record combined into a single card.

2209 Reactor Safety

REFER ALSO TO CITATION(S) 38882, 38910

38017 (CISE—708) Use of loop-seals for the control of the overpressures in hydraulic transients evolving in a sea service water system. Canetta, D.; Capozza, A.; Iovino, G. (Centro Informazioni Studi Esperienze, Milan (Italy)). 1985. 33p. (CONF-8509301—1). NTIS, PC A03/MF A01.

From 7. international round table on hydraulic transients in power stations; Alvkarleby, Sweden (9 Sep 1985).

The transient response following pump trip-offs and start-ups was investigated in the sea water system of a nuclear power plant. Specific care was devoted to water column separation and cavity collapse phenomena. A computer program designed for analysis of complex hydraulic networks was used. It is found that dangerous overpressures can be avoided by the use of loop seals. The design of the vacuum breaker valves of the loop seals and the optimization of overall transient behavior is discussed. 1 reference.

38018 (CONF-860501—12) Fuel pin failure in the PFR/TREAT experiments. Herbert, R.; Hunter, C.W.; Kramer, J.M.; Wood, M.H.; Wright, A.E. (Argonne National Lab., IL (USA); Hanford Engineering Development Lab., Richland, WA (USA); UKAEA Atomic Energy Establishment, Winfrith. Safety and Engineering Science Div.). 1986. Contract W-31109-ENG-38. 10p. NTIS, PC A02. File Number DE86012123.

From Conference on the science and technology of fast reactor safety; Channel Islands, UK (12 May 1986).

The PFR/TREAT safety testing programme involves the transient testing of fresh and pre-irradiated UK and US fuel pins. This paper summarizes the experimental and calculational results obtained to date on fuel pin failure during transient overpower (resulting from an accidental addition of resolivity) and transient undercooling followed by overpower (arising from an accidental stoppage of the primary sodium circulating pumps) accidents. Companion papers at this conference address: (I) the progress and future plans of the programme, and (II) post-failure material movements.

38019 (CONF-860501—13) Post-failure material movement in the PFR/TREAT experiments. Bauer, T.H.; Morman, J.A.; Hill, D.J.; DeVolpi, A.; Goldman, A.J. (Argonne National Lab., IL (USA); UKAEA Atomic Energy Establishment, Winfrith. Safety and Engineering Science Div.). 1986. Contract W-31-109-ENG-38. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012126.

From Conference on the science and technology of fast reactor safety; Channel Islands, UK (12 May 1986).

In the PFR/TREAT experiments the fast neutron hodoscope has provided experimental data on post-failure material movement during Transient Overpower and Transient Under-Cooled Overpower events. Analyses of selected experiments have been done, using SIMMER-II and SAS4A, to validate these codes. Full results of these analyses are presented in the paper. The general conclusion that can be drawn from the analyses that have been made so far is that the hodoscope is providing data which has appropriate resolution in time and space and that the computer models which are being used by the USDOE and the UKAEA provide good representations of fuel redistribution.

38020 (EGG-M—11385-Rev.) Reactor Safety Assessment System. A situation assessment aid for USNRC emergency response. Bray, M.A.; Sebo, D.E.; Dixon, B.W. (EG and G Idaho, Inc., Idaho Falls (USA)). 1985. Contract AC07-76ID01570. 8p. (CONF-851072—1-Rev.). Institute of Electrical and Electronics Engineers, 345 E. 47th Street, New York, NY 10017. File Number TI86011051.

From Expert systems in government symposium; McLean, VA, USA (23 Oct 1985).

The Reactor Safety Assessment System (RSAS) is an expert system under development for the United States Nuclear Regulatory Commission (USNRC). RSAS is intended for use at the NRC's Operations Center in the event of a serious incident at a licensed nuclear power plant. The system uses plant parameter data

and status information from the power plant. It has a rule base that uses the parametric values, the known operator actions, and the time sequence information in the data to generate situation assessment conclusions for use by the NRC Reactor Safety Team. RSAS rules currently cover one specific reactor type and use setpoints specific to one power plant.

38021 (EPRI-NP—4498-Vol.2) Reactor Analysis Support Package (RASP). Volume 2. BWR event analysis guidelines. Final report. Engel, R.E.; Sorensen, J.M.; Fuller, E.D.; Ostenso, A.L.; Keller, L.A. (Levy (S.), Inc., Campbell, CA (USA)). May 1986. 691p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920345.

The experience of recent years has demonstrated an ever-increasing need for utilities operating nuclear power plants to have the means to re-analyze those postulated events that form the bases for plant operation or safety design. The Reactor Analysis Support Package (RASP) provides an integrated, interlinked, and validated code package satisfying a wide range of nuclear utility applications. RASP consolidates existing core physics, thermal-hydraulics, and fuel performance computer codes into an integrated and self-consistent system. The RASP project also involves producing several guideline documents and conducting seminars/workshops to assist the utilities in applying the RASP code package. This report provides detailed guidelines for performing event analyses for BWR operating plants using the RASP codes. The primary intent of these guidelines is to provide guidance for performing safety analyses to meet the intent of the applicable regulations contained in Title 10 of the Code of Federal Regulations (10 CFR) for updating the reactor analysis portion of the safety analyses with specific emphasis on performing reactor core reload licensing analyses. Before using these guidelines and the RASP codes to analyze and predict the transient behavior of a BWR, the analyst must first understand the design and operation of the plant. Therefore, this report presents a general discussion of BWR design and operation with an emphasis on systems, components and structures that impact the behavior of events.

38022 (NUREG—1152) Millstone 3 risk evaluation report. An overall review and evaluation of the Millstone Unit 3 probabilistic safety study. Kelly, G.; Barrett, R.; Buslik, A. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Jun 1986. 126p. NTIS, PC A07/MF A01 - GPO. File Number TI86901520.

In 1981, the US Nuclear Regulatory Commission (NRC) requested Northeast Utilities to perform a design-specific probabilistic safety study (PSS) for Millstone Nuclear Power Station, Unit No. 3 (Millstone 3). In 1983, Northeast Utilities submitted the Millstone 3 Probabilistic Safety Study for review by the NRC staff. The NRC staff prepared the Millstone 3 Risk Evaluation Report, which discusses the findings regarding the PSS. The PSS estimates that the mean annual core damage frequency due to internal and external events is 5×10^{-5} and 2×10^{-5}, respectively. The NRC staff's Risk Evaluation Report estimates that the mean annual core damage frequency is about 2×10^{-4} for internal events and lies between 1×10^{-5} and 2×10^{-4} for external events. The NRC staff estimates that station blackout dominates internal and external event core damage frequencies. The staff recommends that Northeast Utilities perform an engineering analysis on upgrading the diesel generator lube oil cooler anchorage system and on adding a manually operated, AC-independent containment spray system. The staff also recommends that Northeast Utilities prepare two emergency procedures (loss of room cooling and relay chatter due to an earthquake) to help reduce uncertainties. (Subsequent to the completion of this document, Northeast Utilities and the NRC staff have continued a dialogue regarding station blackout from events other than earthquakes. Both Northeast Utilities and the staff have performed additional evaluations, which have drawn their results closer together. Final requirements, if any, for the prevention or mitigation of station blackout from events other than earthquakes have not yet been determined.) 26 refs., 16 tabs.

38023 (NUREG—1177) Safety Evaluation Report related to the restart of Davis-Besse Nuclear Power Station, Unit 1, following the event of June 9, 1985 (Docket No. 50-346). (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Jun 1986. 257p. NTIS, PC A12/MF A01 - GPO. File Number TI86901533.

On June 9, 1985, the Davis-Besse Nuclear Power Station, operated by the Toledo Edison Company, experienced a partial loss of main feedwater while the plant was at 90% power. The ensuing reactor trip was followed by spurious isolation of the steam generators which initiated a chain of events involving a number of equipment malfunctions and several operator errors ultimately interrupting all feedwater for a short period of time. By the time operators were able to restore feedwater, both steam generators had dried out. A letter from the Director of the Office of Nuclear Reactor Regulation, pursuant to 10 CFR 50.54(f) of the Commission's regulations, confirmed that the Davis-Besse facility would not be restarted without NRC approval. The letter also requested that Toledo Edison submit its program for resolving numerous concerns identified by the staff. In response, the license submitted the Davis-Besse Course of Action report. The staff has reviewed that document and other supporting material submitted by the licensee; the staff's evaluation of that information is presented in this report.

38024 (NUREG/CR—4507) HECTR Version 1.5 user's manual. Dingman, S.E.; Camp, A.L.; Wong, C.C.; King, D.B.; Gasser, R.D. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 397p. (SAND—86-0101). NTIS, PC A17/MF A01 - GPO. File Number TI86012875.

This report describes the use and features of HECTR Version 1.5. HECTR is a relatively fast-running, lumped-volume containment analysis computer program that is most useful for performing parametric studies. The main purpose of HECTR is to analyze nuclear reactor accidents involving the transport and combustion of hydrogen, but HECTR can also function as an experiment analysis tool and can solve a limited set of other types of containment problems. New models added to HECTR Version 1.5 include fan coolers, containment leakage, continuous burning, and the capability to treat carbon monoxide and carbon dioxide. Models for the ice condenser, sumps, and Mark III suppression pool were upgraded. HECTR is designed for flexibility and provides for user control of many important parameters, particularly those related to hydrogen combustion. Built-in correlations and default values of key parameters are also provided.

38025 (NUREG/CR—4594) Estimated safety significance of Generic Safety Issue 61. Lehner, J.R.; Perkins, K.R.; Economos, C. (Brookhaven National Lab., Upton, NY (USA)). Jun 1986. Contract AC02-76CH00016. 116p. (BNL-NUREG—51986). NTIS, PC A06/MF A01 - GPO. File Number TI86012286.

The potential threat posed by transient initiated accident sequences involving BWR systems capable of releasing steam into the wetwell airspace and thereby pressurizing the containment has been examined. This study estimates the likelihood of a rupture in one of a number of high pressure steam lines which pass through the wetwell airspace before entering the suppression pool. If the broken steam line is connected to an active steam source, such as a stuck open relief valve, which supplies steam at a high enough rate and over a long enough interval, the suppression pool bypass may result in containment overpressure failure. The three BWR plant systems identified as having components whose failure could lead to a steam discharge into the wetwell airspace and pressurization of the containment are: the Main Steam Relief Valves and associated discharge lines, the High Pressure Coolant Injection turbine exhaust and the steam condensing relief lines in the Residual Heat Removal System. This study outlines the postulated accident sequences, estimates their frequency, and calculates containment response to the proposed steam discharges using the computer code CONTEMPT4. Based on the predicted containment response, the investigation estimates the probability of core melt, the possible fission product release and the associated consequences. Mitigating actions designed to prevent containment failure as well as actions designed to prevent core melt given containment failure are also discussed.

The study concludes that, while some of the sequences could potentially result in core melt and cause significant releases of fission products, the frequency of these sequences are judged to be sufficiently small to remove them as significant contributors to public risk.

38026 **Safety impact of mechanical- and maintenance-induced seal failures of reactor coolant pumps.** Azarm, M.A.; Boccio, J.L. (Brookhaven National Lab., Upton, NY). *Transactions of the American Nuclear Society;* **50**: 357-358(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper presents an investigation of the safety impact resulting from mechanical- and maintenance-induced reactor coolant pump (RCP) seal failures in nuclear power plants. The intention of this study was to estimate the annual frequency for the spectrum of leak rates induced by RCP seal failures for the benefit of various pump designers and plant vendors; and to evaluate their potential impact on plant safety. The safety impact of RCP seal failures was measured by estimating their contribution to core-melt frequency. The study performed was limited to three nuclear power plants; namely, Arkansas Nuclear One Unit 1, Calvert Cliffs Unit 1, and Indian Point Unit 3. The safety impact of mechanical- and maintenance-induced RCP seal failures measured in terms of percentage increase of annual core-melt frequency is estimated to be between 16 and 18% for Babcock & Wilcox and Westinghouse plants. For the Combustion Engineering plants, the percentage increase for annual core-melt frequency would be dependent on the reliability of the vapor seal. If a failure probability of 0.2 is assigned to a vapor seal exposed to full reactor pressure, the percentage increase of annual core-melt frequency would be 5%.

38027 **Use of PRA in assessing BWR vessel level instrumentation.** Yue, D.D. (Nuclear Regulatory Commission, Washington, DC). *Transactions of the American Nuclear Society;* **50**: 358-359(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper discusses the regulatory application of probabilistic risk assessment (PRA) in assessing Generic Issue 50, Reactor Vessel Level Instrumentation in BWRs. Results of this study led to the voluntary implementation of water level measurement improvements in boiling water reactors (BWRs) and formed the basis for a separate Generic Issue 101, BWR Water Level Redundancy. Reactor vessel level instrumentation is used in BWRs to perform a number of safety-related functions such as feedwater control and automatic scram and autostart of emergency core cooling systems (ECCS). Following a break in an instrument reference leg, if there is an additional postulated single failure in another level logic train, the related level instrumentation would indicate a full-scale high level regardless of the actual water level in the reactor vessel. The analysis of transmitter failures is for the plant analyzed and may differ for other BWRs. It illustrates the basic failure mode of transmitters in BWRs.

38028 **Risk-based analysis of allowed outage times in nuclear power plants.** Samanta, P.K.; Wong, S.M.; Boccio, J.L.; Vesely, W.E. (Brookhaven National Lab., Upton, NY). *Transactions of the American Nuclear Society;* **50**: 359-361(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

One aspect of technical specifications (TS) in nuclear power plants is the allowed outage time (AOT) of the components in the safety systems. The AOT for a component is the period of time during the plant operation in which the component can be inoperable, i.e., if a component is found failed, it should be repaired within the AOT defined in the TS of the plant; otherwise the plant must be taken to a shutdown state. US Nuclear Regulatory Commission approval for the AOT extension is required for continued operation. Current AOTs defined in the TS were primarily based on engineering judgments, which included judgment on the safety importance of the component and a qualitative consideration of repair time. Risk- and reliability-based methodologies can be utilized to establish AOTs to control and minimize risks due to an AOT. However, the introduction of risk-based insights into the AOT determination process requires the resolution of a number of issues that impact the evaluation. The Procedures for Evaluating Technical Specifications program plan has identified the issues in an evaluation of the Limerick nuclear plant. In this paper, issues that impact AOT evaluations are addressed, and the insights gained toward their resolution are presented.

38029 **PRA-based plant system reviews.** Higgins, J.; Taylor, J. (Brookhaven National Lab., Upton, NY). *Transactions of the American Nuclear Society;* **50**: 361-362(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This work was performed under the auspices of the US Nuclear Regulator Commission (NRC) to develop methods for probabilistic risk assessment (PRA)-based plant reviews and to actually perform in-depth technical reviews of selected systems at nuclear power plants using PRA as a tool. The reviews were performed at one boiling water and one pressurized water reactor facility in the northeast, each of which had a completed, full-scope, plant-specific PRA. Initially, PRA system priorization techniques were used to assist in the selection of safety systems important to overall plant risk. Then the methods described herein were used to guide and focus the detailed technical reviews of the systems.

38030 **Methodology for risk-based evaluation of emergency response planning.** Touchton, R.A.; Potter, T.E.; Sauter, G.D. (Technology Applications, Inc., Falls Church, VA). *Transactions of the American Nuclear Society;* **50**: 362-363(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

A number of processes and events directly related to offsite emergency planning considerations are modeled in a probabilistic risk assessment (PRA). The results, if properly evaluated and communicated, can provide valuable insights to emergency planners. The PRA analyzes various potential accident sequences; these analyses can be used to identify those few sequences that may require the initiation of emergency response activities. A PRA also models the effectiveness of selected operator actions in mitigating potential radioactive releases. Thus, PRA results can provide guidance valuable not only in assessing the effectiveness of emergency response alternatives but also in considering proposed revisions to emergency planning criteria. This paper presents the results of the methodology development phase of a two-phase Electric Power Research Institute (EPRI)-funded study of how PRA methods and results could be incorporated into the field of emergency planning. The objective of the study is to develop and demonstrate a methodology whereby the results from a completed PRA can be used to broaden the perspective with which certain elements of an emergency response plan are considered.

38031 **Robust methods for failure rate estimation.** Vaurio, J.K.; Linden, G. (Imatran Voima Oy, Helsinki, Finland). *Transactions of the American Nuclear Society;* **50**: 363-364(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Accurate failure rate estimates are important for meaningful probabilistic safety assessments. The purpose of this paper is to develop an effective method for estimating failure rates from scarce data, apply the method to global valve data, and compare it to other methods with numerical data. The results demonstrate the superiority of the proposed parametric robust empirical Bayes (PREB) method over earlier attempts, especially for small samples. The proposed PREB estimates improve on both maximum likelihood estimates and more recent parametric empirical Bayes methods.

38032 **Safety prediction technique for nuclear power plants.** Henry C.D. III; Anderson, R.T. *Transactions of the American Nuclear Society;* **50**: 364-366(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This paper presents a safety prediction technique (SPT) developed by Reliability Technology Associates (RTA) for nuclear power plants. It is based on a technique applied by RTA to assess the flight safety of US Air Force aircraft. The purpose of SPT is to provide a computerized technique for objective measurement of the effect on nuclear plant safety of component failure or procedural, software, or human error. A quantification is determined, called criticality, which is proportional to the probability that a given component or procedural-human action will cause the plant to operate in a hazardous mode. A hazardous mode is characterized by the fact that there has been a failure/error and the plant, its operating crew, and the public are exposed to danger. Whether the event results in an accident, an incident, or merely the exposure to danger is dependent on the skill and reaction of the operating crew as well as external influences. There are three major uses of SPT: (a) to predict unsafe situations so that corrective action can be taken before accidents occur, (b) to quantify the impact of equipment malfunction or procedural, software, or human error on safety and thereby establish priorities for proposed modifications, and (c) to provide a means of evaluating proposed changes for their impact on safety prior to implementation and to provide a method of tracking implemented changes.

38033 **Design quality assurance for plant modifications.** Ankrum, G.T.; Norkin, D.P.; Architzel, R. (Nuclear Regulatory Commission, Washington, DC). *Transactions of the American Nuclear Society;* 50: 367(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The US Nuclear Regulatory Commission's Office of Inspection and Enforcement has conducted direct inspections of the technical aspects of the nuclear plant design process for several plants under construction. It has also evaluated independent design verification programs and engineering assurance programs at a number of other plants under construction. Many of the lessons learned from these construction phase efforts are directly applicable to operating plants undergoing major modifications.

38034 **Optimizing quality assurance program benefits through performance and reliability analysis.** Lewis, R.E. (Gilbert/Commonwealth Inc., Reading, PA). *Transactions of the American Nuclear Society;* 50: 371(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Quality assurance (QA) principles have long been applied in part to many varied industrial enterprises. In general, the main emphasis in the past has been placed largely on standard management practices with the inclusion of quality control or inspection elements. The advent of commercial nuclear power brought the evolution of a more comprehensive approach to the applications of QA programs in this and related industries. However, the application philosophy was aimed almost totally at assuring the safety of the worker and the public. Recently, there has been a strong movement by industry and business in the United States and Europe to apply QA in a more general way to assure overall reliability as well as safety. The key to successfully accomplishing this is the determination of the degree of program intensity appropriate to the item or activity that is part of the total project or operation. This paper describes an approach to enable management to not only make initial determinations of how to apply the elements of a QA program, but how to continuously adjust the program to optimize the benefits that can be obtained.

38035 **Developing indicators to measure the effectiveness of QA program management controls.** Rutland, R.W.; Rusk, J.H. Jr. *Transactions of the American Nuclear Society;* 50: 371-372(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Regulation and enforcement actions address two primary areas of concern: (a) technical adequacy of design, construction, and operation; and (b) management control of activities that could affect technical adequacy. The concept of effectiveness indicators for QA program controls was first developed as an improved audit technique that focused management attention on end results. Line managers readily recognize actual control failures and the need for responsible action. This approach contrasts with audits that focus on total compliance where the possible consequences of (often) trivial deviations from procedural detail were open to challenge. The QA auditors were seldom equipped to argue the technical merits of their implied contention that noncompliance would have led to serious problems. The QA expectation that positive action had to be taken to prevent recurrence of trivial discrepancies created credibility questions that tended to undermine commitment to legitimate elements of the QA program. Developing effectiveness indicators through an approach that analyzed major management control systems and subsystems is a valuable tool that provides a more objective judgment of QA program effectiveness and is an opportunity to revitalize existing QA and administrative controls.

38036 **Integrated nuclear safety review program at PSE & G.** Krishna, P.M. (Public Service Electric & Gas Co.). *Transactions of the American Nuclear Society;* 50: 382(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The concept of self-regulation implies demonstration of a dedicated commitment for aggressive pursuit of our efforts to identify and correct perceived problems. This summary illustrates such self-regulation activity on the part of Public Service Electric and Gas Co. (PSE & G) in the area of safety review management. PSE & G operates Salem 1 and 2 pressurized water reactors, and a third unit, the Hope Creek boiling water reactor, is expected to come online in 1986. As part of a comprehensive set of plans for improvement of Nuclear Department operations, an action plan to improve safety review management activity was undertaken to maximize the quality of reviews and the effective use of resources consistent with the need to assure safe and reliable operation of the plants. Recommendations for improvement of the safety review process included both organizational as well as procedural modifications, with the central focus being establishment of an integrated nuclear safety review program. Major elements of the implemented program are described.

38037 **Full-term licensing conversion process in the systematic evaluation program.** Parkyn, J.D. (Dairyland Power Cooperative). *Transactions of the American Nuclear Society;* 50: 402(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Historically, nuclear power plants were licensed for a period of time following construction and operated as a test case to see whether the operation would be viable and safe; then their provisional operating license was converted to a full-term operating license. The La Crosse boiling water reactor (LACBWR) is one of these conversion licensees. LACBWR has had a great deal of activity in the area of the new licensing. Examples of modifications and upgrades to the plant requiring license application and efforts to convert the plant license to full-term are discussed. The conversion of the provisional license to full-term should somewhat reduce future impacts of questions arising about the adequacy of older plants which have not been compared to recent standards.

38038 **FSAR verification program.** Bebko, J.J. (Niagara Mohawk Power Corp.). *Transactions of the American Nuclear Society;* 50: 401-402(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

For the Nine Mile Point Unit 2 plant, a comprehensive program was established to verify the project's 38-volume FSAR. This program encompassed both the verification process and a detailed accounting system for the long-term maintenance of the FSAR. The accounting system is computer-based and provides not only the necessary interface between the commitments and the identified supporting documents, but an on-line search program and the means for regular updating of the FSAR. The verification process used was a three-step process; the identification of units of verification, the research of supporting documents, and the preparation of data for input into the computer system. From a liability standpoint, the technical error rate on a per commitment basis indicates a vulnerability of ~11,250 incorrect statements. If even 1% of

these was potentially findable, at say the rate of $100,000 for each find; the liability reduction of a comprehensive FSAR verification program is on the order of $11.25 million.

38039 **Identification of regulatory requirements that have marginal importance to risk.** Little, W.W.; Mullen, M.F.; Boegel, A.J.; Scott, W.B. (Pacific Northwest Lab., Richland, WA). *Transactions of the American Nuclear Society;* 50: 404-405(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The US Nuclear Regulatory Commission (NRC) has initiated a program to review the effectiveness of light water reactor (LWR) regulatory requirements in limiting risk. More specifically, the objective is to identify regulatory requirements which, if deleted or appropriately modified, would improve the effectiveness of NRC's regulatory program without adversely affecting safety. The initial scope of the program covers the LWR regulatory requirements and guidance associated with 10CFR50. The Pacific Northwest Laboratory (PNL), under contract to the NRC, is assisting in this program. This paper presents preliminary findings based on one element of the program, namely, a systematic effort to gather the views of various interested parties concerning selected aspects of current LWR regulatory requirements.

38040 **Technical specification improvement.** Webster, S.A.; Johnson, S.E. (Combustion Engineering, Inc.). *Transactions of the American Nuclear Society;* 50: 406(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The purpose of this paper is to examine the work being done at Combustion Engineering (C-E) and in the nuclear industry to improve technical specifications. The year 1985 is one that has seen increased attention paid to improving technical specifications, both at the US Nuclear Regulatory Commission (NRC) and within the nuclear industry. Continuing attention is required to ensure that the momentum that has developed is not lost. The observation is that removal of the cycle-dependent variables is of the most immediate benefit. This can be accomplished with minimum effort and should reduce the number of license amendments by about one third of their present level. The major effort in the NRC's Technical Specification Improvement Project (TSIP) and the Atomic Industrial Forum (AIF) Subcommittee of Technical Specifications is to implement the so-called George rule to split the technical specifications. This will require a large effort and should result in reducing the size of the technical specifications by about one half. However, the items to be relocated are not necessarily those creating a large number of license changes. It is anticipated that implementation of the George rule will have about the same effect on the licensing process as removal of the cycle-dependent variables.

38041 **Small inherently safe reactor without an ECCS.** Hashemi, S.; Bhatnagar, R.; Christensen, R.N.; Katori, T.; Miller, D.W.; Smith, P.K. (Ohio State Univ., Columbus). *Transactions of the American Nuclear Society;* 50: 425-426(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Several possibilities exist to incorporate inherent safety into plant design. The most acceptable option is based on utilization of the proven technology and new innovative ideas in the design of a smaller inherently safe power reactor. The reactor described in this paper is a 400-MW(e) plant with a proven boiling water reactor (BWR)/6 core design and a combination of BWR and pressurized water reactor concepts. The introduction of a pressurized suppression pool system and accumulator tanks ensures the safe operation of the reactor without the need for an external emergency core cooling system and thus the diesel generators are eliminated. Studies have shown that plant availability is increased, due to simplifications caused in design, without jeopardizing plant safety. The construction, licensing, operation, and maintenance are postulated to be simplified due to utilization of the inherent safety of the plant rather than relying on external safety systems.

38042 **Small inherently safe reactor with a passive ECCS.** Christensen, R.N.; Browning, N.J.; Jayanti, S.; Miller, D.W.; Wang, C.K.; Zimmerman, M.A. (Ohio State Univ., Columbus). *Transactions of the American Nuclear Society;* 50: 426-428(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Public concern about the safety of nuclear power plants has resulted in a search for inherently safe plants. The concept of an inherently safe reactor presented in this paper responds to that need. The plant, rated at 340 MW(e), is based on the state-of-the-art technology of light water reactors and the high-temperature gas-cooled reactors (HTGRs). The reactor core uses shortened assemblies of the boiling water reactor (BWR)/6 design. The steam delivered to the turbines is generated in a secondary system similar to that in a pressurized concrete reactor vessel (PCRV) as in the HTGRs.

38043 **Process inherent, ultimately safe BWR.** Forsberg, C.W. (Oak Ridge National Lab., TN). *Transactions of the American Nuclear Society;* 50: 428-429(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

A new type of boiling water reactor (BWR) with passive safety systems has been conceived - the process inherent, ultimately safe (PIUS) BWR. The reactor core and non-nuclear portion of the plant are similar to current BWR designs, but a special, prestressed concrete reactor vessel (PCRV) with unique internal design replaces most of the nuclear island. A natural circulation PIUS BWR with key components inside the PCRV is described. Forced circulation is an option. The reactor pressure, temperature, and thermal efficiencies match current BWRs.

38044 **Natural circulation integral reactor.** Bingham, B.E.; Kulynych, G.E.; Mulligan, J.B. (Babcock & Wilcox, Co.). *Transactions of the American Nuclear Society;* 50: 430(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The NCIR is a self-pressurized reactor with core, steam generators, and pressurization steam space all within a single steel pressure vessel. One of the key features of the NCIR is startup without outside power. The NCIR will respond easily to changes in power demand without operator action. The NCIR has important inherent safety features. By minimizing and simplifying reactor safety and auxiliary systems, the NCIR allows the total plant to be reduced in size and complexity.

38045 **Gamma scanning of the TMI-2 lower reactor vessel head via in-core detectors.** Rainisch, R.; Fricke, V.R.; Warren, H.D.; Caldwell, C.S. (Burns & Roe, Inc., Middletown, PA). *Transactions of the American Nuclear Society;* 50: 460-461(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The accident at Three Mile Island Unit 2 (TMI-2) resulted in a significant accumulation of fuel debris at the bottom of the reactor pressure vessel (RPV). The existence of this fuel debris bed was confirmed by video inspections of the lower head. However, the volume/weight of debris in this area could not be quantified based on the reference inspections. The scanning effort was undertaken to quantify the volume of debris in the RPV lower head. The measurements are based on vertical profiling of the gamma activity at the bottom of the RPV. The measurements were obtained using miniature ion chamber detectors. Access for profiling was via the center calibration tubes of the in-core detectors already in place. Mechanical probing of the reference tubes, prior to scanning, found 16 out of 17 calibration tubes blocked at points outside the vessel. Although the original objective of quantifying the volume of debris in the lower head was prevented, a gamma profile was obtained at location L-11. At this location, the ion chamber came to an impassable obstruction 20 cm above the RPV inner surface, limiting the upper boundary of the derived gamma profile to this elevation. The paper is an attempt to characterize the reference rubble bed based on the derived gamma scan. This is obtained by calculating the

dose rates in the lower head using computer code modeling and comparative analysis of calculated versus measured profiles.

38046 **Contamination in the TMI-2 plenum.** Augustine, F. Jr.; Worku, G. (Burns & Roe, Inc., Middletown, PA). *Transactions of the American Nuclear Society;* 50: 461-462(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

In May 1985 the plenum was removed from the Three Mile Island Unit 2 (TMI-2) reactor. The 55-ton cylindrical assembly, which normally sits over the reactor core, was lifted in air and moved to the deep end of the refueling canal to be stored underwater. The plenum was removed so that reactor refueling could start in September 1985. In preparation for plenum removal, thermoluminescent dosimeters (TLDs) were lowered into the plenum so that contamination levels ($\mu Ci/cm^2$) for the plenum could be estimated. These contamination levels were used to calculate anticipated personnel dose rates during various phases of plenum removal. Since the plenum was removed in air rather than underwater, it was necessary to know dose rates more accurately.

38047 **Role of surface vaporization in low-volatility fission product release experiments.** Reynolds, A.B.; Kelly, J.L.; Kim, S.T. (Univ. of Virginia, Charlottesville). *Transactions of the American Nuclear Society;* 50: 462-463(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Source term analysis requires models for the release of relatively low-volatility fission products such as barium, strontium, ruthenium, etc. from fuel that may be present in debris beds following fuel melting. The objective of this paper is to provide a comparison between the fission product release rates obtained experimentally by Albrecht et al. at the SASCHA Facility at Karlsruhe with values calculated from a mass transfer model. Also, available data from the HI test described by Lorenz at Oak Ridge National Laboratory and one result from the relative volatility study are included in the comparison. This comparison may serve as a basis for determining the extent to which vaporization can be supported as the rate-controlling mechanism in the release of certain fission products from fuel particles. It is recommended that mass transfer correlations appropriate to the fuel or fuel debris geometry be used to calculate fission product release rates from such material in a severe reactor accident.

38048 **High-range containment radiation monitor response to post-accident fission product releases.** Rich, J.M.; Andrews, B.J.; Lahti, G.P.; Pichurski, D.J.; Re, G.C. (Sargent & Lundy, Chicago, IL). *Transactions of the American Nuclear Society;* 50: 464-465(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Two high-range containment radiation monitors (HRCRMs) have been installed in the drywell at the James A. FitzPatrick nuclear power station. These monitors were initially required only to provide a reasonable assessment of area radiation conditions inside the containment following a design basis accident. Recently, however, in addition to the original requirement, these monitors have been considered as a means for obtaining a gross estimate of core damage following an accident. One way to obtain this estimate is to correlate the HRCRM reading with a set of precalculated readings based on a series of hypothetical core fission product releases. These HRCRM readings can be used as an indicator of the airborne radioactivity potentially available for release. The results of this study indicate that within reasonable bounds the HRCRM response is not extremely sensitive to either detector location or contained sources.

38049 **ALARA and maintenance productivity improvements through effective BWR undervessel shielding.** Ciarlone, D.F.; Dedrich, M.R.; Hassall, J.B. (ALARA Shields). *Transactions of the American Nuclear Society;* 50: 465-466(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Control rod drive (CRD) removal and replacement, as well as other routine under-vessel maintenance and surveillance tasks, have long been recognized as repetitive high-dose jobs for boiling water reactors (BWRs). This is primarily because normal operations contaminate the CRD flange assemblies to the degree that they become intense sources of radiation. The resulting under-vessel occupational dose rates routinely range as high as 700 mrem/h, and these dose rates persist for several months after reactor shutdown. Hence, BWR under-vessel maintenance and surveillance poses a very serious outage manpower management problem for the BWR manager. The most obvious and most desirable but most elusive solution to this problem is a shielding device that: 1) produces dramatic reductions in the radiation emanating from the individual CRD Flanges; 2) provides for easy installation and removal by fully suited under-vessel workers; and 3) permits the workers to perform all of their under-vessel maintenance and surveilance tasks without the loss of the protection afforded by the shielding. The CRD flange radiation shield (CRDFRS) is specifically designed to satisfy all of these principal objectives. It is, therefore, the first proposed solution to directly and effectively address the BWR undervessel outage manpower management problem at its cause.

38050 **Changes in iodine volatility resulting from gamma irradiation of aqueous iodine solutions.** Marshall, P.W.; Lutz, J.B.; Kelly, J.L. (Univ. of Virginia, Charlottesville). *Transactions of the American Nuclear Society;* 50: 467(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

An understanding of iodine behavior is necessary to properly evaluate the iodine source term in a core-disruptive light water reactor accident. The effects of factors, such as pH, temperature, and iodine concentration, on the relative amounts of volatile (I_2, HOI) and nonvolatile (I^-, IO_3^-, I_3^-, etc.) species in an air-water system have been studied extensively. However, the effects of radiation do not have a broad experimental base. The objective of this research was to evaluate the effects of gamma radiation of aqueous iodide solutions with respect to producing volatile iodine species.

38051 **Time dependence of the iodine partition coefficient in an unirradiated system.** Marshall, P.W.; Lutz, J.B.; Kelly, J.L. (Univ. of Virginia, Charlottesville). *Transactions of the American Nuclear Society;* 50: 468(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The iodine partition coefficient (IPC) is defined as the ratio of the liquid-phase iodine concentration to the vapor-phase iodine concentration. The value of the IPC may vary significantly with time in a given air-water system, depending primarily on the pH of the system. Previous studies have been directed at evaluating the IPC at a single time shortly (1 to 12 h) after introduction of iodine into the system. However, for purposes of iodine source term calculation in the event of a core-disruptive light water reactor accident, a knowledge of the time dependence of the IPC may be important. Therefore, this research had as its objective the measurement of the IPC as a function of time for a range of concentrations (10^{-7} to 10^{-6} g I/cm^3) and pH (5, 9, and 11). All experiments were performed at ~25°C and in the absence of a significant radiation field. Iodine was introduced as either I_2 or NaI, with 8.05-day ^{131}I used as a tracer.

38052 **Search for excellence: a progress report from the Electric Power Research Institute.** Starr, C. (Electric Power Research Institute, Palo Alto, CA). *Transactions of the American Nuclear Society;* 50: 483(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Electric Power Research Institute (EPRI), now 12 years old, was formed by the electric utility industry in response to the threat of federal legislation to create a government agency, funded by a tax on utility gross revenue, to undertake utility research and development. EPRI is a nonprofit organization established to manage a coordinated national R & D program of the electric power industry. EPRI is supported through the cost of

electricity and represents a novel form of institutional intermediary between the consuming public, the utilities, and the researchers. EPRI selects and funds research projects designed to develop or improve technologies that will help the utility industry meet present and future electric energy needs in environmentally and economically acceptable ways. EPRI's activities are coordinated with those of government agencies, individual utilities, manufacturers and vendors, and comparable organizations in many other countries. As EPRI has evolved, its program emphasis has broadened from chiefly long-term projects to include those aimed at achieving relatively near-term results.

38053 Development of a scram reduction program. Palmer, F.A. (Commonwealth Edison Co.). *Transactions of the American Nuclear Society;* **50**: 494(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

A scram reduction program was developed by Commonwealth Edison Co. (CECo) in 1984 in response to new Institute of Nuclear Power Operations (INPO)/Nuclear Utility Management and Human Researches Committee goals. The goal was to reduce unplanned scrams to three per unit for all US nuclear utilities since worldwide data indicated that improvement could be made at most US plants. The program developed is now in place and a systematic attack is in progress starting with the most cost-effective items. CECo is optimistic that this program will have a substantial payoff in both reduced scram frequency and improved reactor safety by reducing unplanned challenges to safety systems.

38054 Reducing scrams by modifying reactor setpoints for a Westinghouse four-loop plant. Chao, J.; Layman, W.H.; Vine, G. (Electric Power Research Institute, Palo Alto, CA). *Transactions of the American Nuclear Society;* **50**: 504-505(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The operating statistics of nuclear power plants show that a large number of reactor scrams have occurred and resulted in unscheduled plant outages. The safety and economic significance of unnecessary scrams in nuclear plants warrants concentrated effort. Several approaches are being taken to reduce the scram frequency. They are better operator training, improved equipment reliability, and better operating procedures. The effort on scram reduction at the Nuclear Safety Analysis Center (NSAC) complements these approaches. Specifically, NSAC is performing thermal-hydraulic analyses to relax or eliminate a number of scram setpoints without violating safety limits. It is believed that through this means a significant fraction of the scram occurrences will be eliminated.

38055 Setpoint relaxation for scram reduction on C-E PWRs. Ching, B.; Chiu, C.; Chao, J. (Combustion Engineering, Inc.). *Transactions of the American Nuclear Society;* **50**: 505-506(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

This study examines the feasibility of relaxing the reactor protection system (RPS) trip setpoints of Combustion Engineering (C-E) pressurized water reactors so that unnecessary scrams may be avoided. Unnecessary scrams are those that are not required to protect fuel integrity, plant equipment, or public health and safety. They result in lost generating capacity, pose unnecessary challenges to plant equipment, and are an operational nuisance. With relaxed trip setpoints, unnecessary scrams would be avoided by allowing greater operational flexibility. This scram reduction study was sponsored by the Nuclear Safety Analysis Center of the Electric Power Research Institute. The scram reduction program was separated into two parts. In the first part, C-E reactors with analog RPS's were examined. In the second part, the reactors with digital systems were studied.

38056 Westinghouse domestic PWR automatic trip evaluation. Andre, G.R.; Candris, A.S. (Westinghouse Electric Corp.). *Transactions of the American Nuclear Society;* **50**: 506-507(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

An analysis was completed that examined the automatic trip occurrences for Westinghouse domestic pressurized water reactors. The data utilized, which included all automatic trip outages from 1973 to 1983, was extracted from the Westinghouse Reliability Data Base (WRDB). It encompassed 31 plants with a1.5 million operating hours and 1800 automatic trips. Equipment failures account for over 50% of the automatic trips, and human actions (operator, test, and maintenance) account for nearly 30%. The remaining 20% is composed of administrative, refueling, regulatory restriction, operator training and licensing exam, startup testing, and unidentifiable causes. It should be noted that investigations to determine root causes indicate that numerous trips reported in the equipment failure category were actually related to human actions. Building on the information generated by the study summarized herein, Westinghouse, in conjunction with the utilities in the Westinghouse Owners Group, has recently undertaken an aggressive and comprehensive trip reduction program. Under this program, all automatic trips at Westinghouse units will be systematically evaluated to identify their root causes.

38057 Planning and training in emergency preparedness. Perkins, T.G. (Singer Corp.). *Transactions of the American Nuclear Society;* **50**: 511(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Link Simulation Systems Division of the Singer Company is combining its tactical simulation and display system with state-of-the-art decision and control technology to provide a combined operations, planning, and training (COPAT) system. This system provides for the total integration of the three primary responsibilities of emergency managers: planning and training for and decision and control of an emergency. The system is intended to be a complete operations center for emergency management personnel. In the event of a natural disaster or man-made emergency, the national, state, county, and city emergency managers require a secure and reliable operations center. The COPAT system combines the decision and control capabilities with proven simulation techniques allowing for integrated planning and training. The hardware system, software, data bases, and maps used during planning and training are the same as those used during actual emergencies.

38058 Training recommendations for ERG-based emergency operating procedures. Hine, R.C. (Westinghouse Corp.). *Transactions of the American Nuclear Society;* **50**: 511-513(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

Since the accident at Three Mile Island nuclear power plant, emergency operating procedures (EOPs) have undergone some revolutionary changes. Many of the EOPs are now symptom based rather than event based. Some now have the human-engineered, two-column arrangement. EOPs have been developed for accidents beyond design basis, which include multiple accidents and/or equipment failures. The new EOPs are unlike the typical emergency procedures the plant operators have seen in the past. The event-based procedures were normally quite wordy and difficult to follow. In an accident situation, the operator in charge of the plant might not even open the procedures until the plant is stabilized. The EOP steps are well defined with the two-column format and more conducive to operator use. Utility owners groups have created some excellent guidelines for EOP development. However, the effectiveness of the EOPs is dependent on how the operators use them. Training has the responsibility of picking up where EOP development has left off. This paper discusses a recommended training program for effectively training personnel on the EOPs.

38059 Hammer is the last resort. Whitesel, R.N. (GPU Nuclear Corp., Parsippany, NJ). *Transactions of the American Nuclear Society;* **50**: 514-515(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The accident at Three Mile Island Unit 2 (TMI-2) spawned a number of studies of the organization and staffing needed for operation of nuclear power plants. The concept of the independent safety engineering group (ISEG) was one of the results. This paper

addresses the current effectiveness of ISEGs and describes a technique for improving them.

38060 **Improved point-kinetics model for the BWR control rod drop accident.** Neogy, P.; Wakabayashi, T.; Carew, J.F. (Brookhaven National Lab., Upton, NY). *Transactions of the American Nuclear Society;* 50: 537-538(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

In recent years, a number of multidimensional spatial kinetics calculations of the boiling water reactor (BWR) rod drop accident (RDA) have been performed. However, the complex nature of the RDA has made these calculations difficult, and has prevented the interpolation of the calculations to similar RDAs of interest. In the present analysis, as a means for interpolating available RDA calculations, an improved point-kinetics model, which reproduces the results of detailed spatial kinetics calculations, has been formulated.

38061 **Space reactor safety.** Bunch, D.F. (DOE, Washington, DC). pp 605-608 of IECEC '84: Advanced energy systems - their role in our future; Proceedings of the Nineteenth Intersociety Energy Conversion Engineering Conference, San Francisco, CA, August 19-24, 1984. Volumes 1, 2, 3, & 4. La Grange, Park, IL; American Nuclear Society (1984). (CONF-840804—).

From Intersociety energy conversion engineering conference; San Francisco, CA, USA (19 Aug 1984).

Attention is given to spacecraft missions which have been identified as candidates for application of new-generation nuclear power systems, from the viewpoint of safety criteria. An evaluation is conducted of the SP-100 space nuclear reactor program, whose mass, power, service life and volume characteristics will have an impact of questions of safety. It is concluded that some relaxation of performance standards may be required in the course of design development in order to meet the requisite safety goals. 7 references.

25 ENERGY STORAGE

2501 Magnetic

38062 **(LA-UR—86-2184) Coil protection for a utility scale superconducting magnetic energy storage plant.** Loyd, R.J.; Schoenung, S.M.; Hassenzahl, W.V.; Rogers, J.D.; Purcell, J.R. (Bechtel National, Inc., San Francisco, CA (USA); Lawrence Berkeley Lab., CA (USA); Los Alamos National Lab., NM (USA); GA Technologies, Inc., San Diego, CA (USA)). 1986. Contract AC03-76SF00098;W-7405-ENG-36. 8p. (CONF-860705—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012439.

From IEEE Power Engineering Society summer meeting; Mexico City, Mexico (20 Jul 1986).

Superconducting Magnetic Energy Storage (SMES) is proposed for electric utility load leveling. Attractive costs, high diurnal energy efficiency (≧ 92%), and rapid response are advantages relative to other energy storage technologies. Recent industry-led efforts have produced a conceptual design for a 5000 MWh/1000 MW energy storage plant which is technically feasible at commercially attractive estimated costs. The SMES plant design includes a protection system which prevents damage to the magnetic coil if events require a rapid discharge of stored energy. This paper describes the design and operation of the coil protection system, which is primarily passive and uses the thermal capacity of the coil itself to absorb the stored electromagnetic energy.

2505 Flywheels

38063 **(CONF-860810—9) Development of regenerable energy storage for space multimegawatt applications.** Olszewski, M. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011070.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

A program has recently been initiated as a part of the national Strategic Defense Initiative (SDI) to develop energy storage technology for space power applications. This program is jointly conducted by the Department of Energy and the Department of Defense. It is focused on the development of advanced technologies in regenerable energy storage that will be required for generation of multimegawatt levels of sprint power for SDI space missions. Energy storage technology considered in the program relate to devices that have a high specific capacity for energy storage, which can provide high levels of electric power on demand, and which may be recharged with electric power. The devices of principal interest are electrochemical batteries, chemical fuel cells, and electromechanical flywheels (the latter includes the motors and generators used to provide the electrical to mechanical coupling). The intent of the program is to resolve technical feasibility issues associated with an electrically regenerable energy storage system satisfying SDI needs. Specifically, energy storage technology will be developed through the proof-of-concept stage within the next six years that provides a specific power greater than 2.5 kW/kg with an energy storage density of at least 450 kJ/kg.

2506 Thermal

38064 **(CONF-860810—11) Dual temperature thermal storage with complex compounds.** Rockenfeller, U.; Martin, J.F. (Rocky Research Corp., Boulder City, NV (USA); Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011511.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Storage of thermal energy through the formation or dissociation of complex compounds is described. A solid-vapor reaction of an absorbant, a metal inorganic salt, and an absorbate, the ligand of the complex provides energy storage for a heat pump cycle. One system is capable of dual temperature storage, that is storage of cool for air conditioning and storage of heat for heating. Laboratory experiments which define the material and reaction characteristics of a sodium bromide/ammonia system were performed. The reaction rates, storage density and other operating parameters are described in functional form. The performance of a heat pump storage system is projected from these experimentally determined properties. The resulting system compares favorably with existing cool storage systems and with proposed heat or cool storage systems.

38065 **(LA-UR—86-1840) Integrated heat pipe-thermal storage design for a solar receiver.** Keddy, E.S.; Sena, J.T.; Woloshun, K.; Merrigan, M.A.; Heidenreich, G. (Los Alamos National Lab., NM (USA); Sundstrand Corp., Rockford, IL (USA)). 1986. Contract W-7405-ENG-36. 8p. (CONF-860810—5). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011235.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Light-weight heat pipe wall elements that incorporate a thermal storage subassembly within the vapor space are being developed as part of the Organic Rankine Cycle Solar Dynamic Power Systems (ORC-SDPS) receiver for the space station application. The operating temperature of he heat pipe elements is in the 770 to 810°K range with a design power throughput of 4.8 kW per pipe. The total heat pipe length is 1.9 M. The Rankine cycle boiler heat transfer surfaces are positioned within the heat pipe vapor space, providing a relatively constant temperature input to the vaporizer. The heat pipe design employs axial arteries and distribution wicked thermal storage units with potassium as the working fluid. Stainless steel is used as the containment tube and screen material. Performance predictions for this configuration have been conducted and the design characterized as a function of artery geometry, distribution wick thickness, porosity, pore size, and permeability. Details of the analysis and of fabrication and assembly procedures are presented. 2 refs., 8 figs.

38066 **(LBL—20180) Impact of operation and control strategy on the performance of a thermal energy storage system.** Warren, M.L. (Lawrence Berkeley Lab., CA (USA)). May 1986. Contract AC03-76SF00098. 18p. (CONF-860810—13). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011923.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

The method of operation and control of a thermal energy storage system will have significant impact on the value of the system to both the customer and the utility. The annul performance for different operating and control strategies of thermal energy storage systems can be compared by simulation analysis. In the paper, simulation of the annual performance of a thermal storage system is based on hourly cooling loads generated with a DOE2 simulation for a typical small office building. The thermal storage system is sized to meet the maximum daily load for the building. The comparable conventional system is sized to meet the typical building peak load. The operation of the thermal storage system is then modeled hour by hour. Results of the simulation analysis show that while chiller priority control achieves the desired peak load reduction, only that part of the cooling load greater than the chiller capacity is shifted to partial-peak or off-peak hours. The chiller continues to run, charging storage, through the evening hours. Application of storage priority control shifts a greater portion of the annual cooling from on-peak to partial-peak and off-peak hours. This results in greater cost savings to a utility customer on time-of-day rates.

38067 **(LBL—21548) Energy conversion processes supporting advanced thermal energy storage technologies.** Otto, R.J.; Berdahl, P.; Hunt, A.J. (Lawrence Berkeley Lab., CA (USA)). May 1986. Contract AC03-76SF00098. 8p. (CONF-860810—15). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012018.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Research that focuses on fundamental aspects of energy conversion could lead to innovative and improved energy storage technologies. Research progress in two energy conversion processes is summarized and the associated storage technologies described. These two processes are particle catalyzed solar photodissociation for thermochemical energy conversion and storage, and the controlled emission of thermal radiation using narrow-bandgap semiconductor materials.

38068 **(NP—6752267) High temperature Aquifer Thermal Energy Storage. Report on preliminary research, design and construction of high-temperature Aquifer Thermal Energy Storage.** (Nielsen og Rauschenberger Raadgivende Ingenioerer, Virum (Denmark)). Dec 1985. 197p. (In Danish). NTIS (US Sales Only), PC A09/MF A01 . File Number DE86752267.

This report describes experience with preliminary investigations, dimensioning and implementation of thermal storage in ground water reservoirs. Aquifer Thermal Energy Storage (ATES) is used for storing thermal energy (heat) from a period of surplus to a period of deficit thus reducing the net energy consumption. Heat is stored by injection of hot water into the ground water reservoir e.g. during summer and recovered by reversing flow directions e.g. during winter. From an economic point of view the implementation of high temperature thermal energy storage in aquifers is limited to specific areas with favourable local conditions. These conditions include: hydrogeology, distance from store to heat production/consumption, temperatures of surplus heat production and in district heating system and price relations for heat production. Especially price relations and temperature conditions are important: it can be concluded, that heat to be stored must be available at a very low cost or free and that measures have to be taken in order to increase system efficiency (defined as the ratio of recovered heat in the district heating system to the stored heat). The latter is done by increasing storage temperature or by lowering the return temperature of the district heating system. Apart from the economic aspects ATES leads to environmental benefits as emission of smoke are reduced due to less consumption of fossil fuels. (eg).

38069 **(PNL—5818) Initial study of thermal energy storage in unconfined aquifers.** Haitjema, H.M.; Strack, O.D.L. (Minnesota Univ., Minneapolis (USA)). Apr 1986. Contract AC06-76RL01830. 107p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86012868.

Convective heat transport in unconfined aquifers is modeled in a semi-analytic way. The transient groundwater flow is modeled by superposition of analytic functions, whereby changes in the aquifer storage are represented by a network of triangles, each with a linearly varying sink distribution. This analytic formulation incorporates the nonlinearity of the differential equation for unconfined flow and eliminates numerical dispersion in modeling heat convection. The thermal losses through the aquifer base and vadose zone are modeled rather crudely. Only vertical heat conduction is considered in these boundaries, whereby a linearly varying temperature is assumed at all times. The latter assumption appears reasonable for thin aquifer boundaries. However, assuming such thin aquifer boundaries may lead to an overestimation of the thermal losses when the aquifer base is regarded as infinitely thick in reality. The approach is implemented in the computer program UCATES, which serves as a first step toward the development of a comprehensive screening tool for ATES systems in unconfined aquifers. In its present form, the program is capable of predicting the relative effects of regional flow on the efficiency of ATES systems. However, only after a more realistic heatloss mechanism is incorporated in UCATES will reliable predictions of absolute ATES efficiencies be possible.

38070 **(PNL-SA—13915) Aquifer thermal energy storage in the United States.** Kannberg, L.D. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 6p. (CONF-860655—12). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012147.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

The US Department of Energy (DOE) has funded investigation of aquifer thermal energy storage (ATES) since 1975. The investigation scope has encompassed numerical modeling, field testing, economic analyses, and evaluation of institutional issues. Current US efforts are concentrated on a high-temperature (up to 150°C) ATES field test in Minnesota. Results to date indicate that high-temperature aquifers are good candidates for seasonal energy storage in central solar heating plants and hybrid district heating systems. Findings from earlier studies suggest that aquifer systems operated at much lower temperatures (<50°C) also may be useful and very economical in systems employing heat pumps.

38071 **(STEV-FVE—86-1) Rock caverns used for oil storage, as heat stores. A case study in Karlshamn.** Hillstroem, C.G. (Statens Energiverk, Stockholm (Sweden); VIAK AB, Falun (Sweden)). Jan 1986. 88p. (In Swedish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752482.

The aim of this project has been to study heat storage in empty rock caverns used for oil storage. A case study of Karlshamn has been made. Two alternatives for storage of waste heat have been investigated. 1 Cold storage: water temp. 18 degrees C, rock cavern Vol. 380000 m^3. 2 Hot storage: water temp 75 dgrees C, rock cavern Vol. 180000 m^3. Biological and mechanical methods for cleaning of the former oil stores have been studied. The problem of wave propagation at the interface between water layers of different temperature have been considered. The heat losses have been estimated to be 11% for the cold alternative, and 8% for the hot alternative. The savings for the cold alternative have been calculated to 8.4 MSEK the first 10 years, with investment costs of 35 MSEK and 6.2 year pay-off time. The savings for the hot alternative have been calculated to 8.5 MSEK the first 10 years, with investment costs of 43 MSEK and 6.9 year pay-off time.

2508 Chemical

REFER ALSO TO CITATION(S) 38063

2509 Batteries

38072 (AD-A—165657/8/XAB) Calcium/thionyl chloride battery technology. Final report, February 1982-June 1985. Counts, T. (Eagle-Picher Industries, Inc., Joplin, MO (USA). Electronics Div.). Dec 1985. 359p. NTIS, PC A16/MF A01.

This final report documents the development efforts conducted by the Lithium Batteries Group of the Couples Department of Eagle-Picher Industries. The objective of the project was to develop calcium-thionyl chloride cell technology. The original project was divided into two main tasks. Task One was to consist of component optimization and stability studies. Once sufficiently advanced, the ongoing results of Task One were to be integrated with Task Two. Task Two was to consist of demonstration of an optimized primary cell. In July, 1983, the program was redirected. Task Two was split, with effort to be directed toward both the original primary cell and toward a high-discharge-rate-reserve configuration cell. Additional electrolyte salts were to be evaluated as a means of improving the storability of the active calcium-thionyl chloride cell.

38073 (N—86-21978) Lightweight nickel electrode for nickel hydrogen cells and batteries. Britton, D.L. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 10p. (NASA-TM—87253; E—2942; CONF-860688—3). NTIS, PC A02/MF A01.

From 32. NASA/US Army international power sources symposium; Cherry Hill, NJ, USA (8 Jun 1986).

The nickel electrode was identified as the heaviest component of the nickel hydrogen (NiH_2) battery. The NASA Lewis Research Center is developing nickel electrodes for NiH_2 battery devices which will be lighter in weight and have higher energy densities when cycled under a low Earth orbit regime at deep depths of discharge. Lightweight plaques are first exposed to 31 percent potassium hydroxide for 3 months to determine their suitability for use as electrode substrates from a chemical corrosion standpoint. Pore size distribution and porosity of the plaques are then measured. The lightweight plaques examined are nickel foam, nickel felt, nickel plastic and nickel plated graphite. Plaques are then electrochemically impregnated in an aqueous solution. Initial characterization tests of the impregnated plaques are performed at five discharge levels, C/2, 1.0 C, 1.37 C, 2.0C, and 2.74 C rates. Electrodes that passed the initial characterization screening test will be life cycle tested. Lightweight electrodes are approximately 30 to 50 percent lighter in weight than the sintered nickel electrode.

38074 (SAND—86-7102C) Sodium-sulfur battery systems development. Beninga, K.J.; Butler, B.L. (Science Applications International Corp., San Diego, CA (USA)). 8 May 1986. Contract AC04-76DP00789. 23p. (CONF-860810—12). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011424.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

Results of Na-S battery systems analyses are presented. The performance of various network configurations for a load leveling battery in the presence of multiple cell failures was assessed with the use of a computer model. Results indicate that the life of a battery can be extended by a factor of 3 to 4 with the use of a switch to assure either open circuit or short circuit failure of each cell. Other means of extending the life of the battery are presented. Future work is outlined for the effort to design a 100 MW-h Na-S load leveling battery.

38075 Flow cytometric measurement of total DNA and incorporated halodeoxyuridine. Gray, J.W.; Dolbeare, F.A. (to Dept. of Energy, Washington, DC). US Patent 4,585,736. 29 Apr 1986. Filed date 18 Oct 1983. vp.

A method is described for the simultaneous measurement of total cellular DNA content and of incorporated halodeoxyuridine which consists of: reacting cells with radioactive labeled halodeoxyuridine; denaturing cellular DNA with a denaturing agent; adding to the reaction medium monoclonal antibodies reactive with halodeoxyuridine; reacting the bound monoclonal antibodies with a labeled second antibody; incubating the mixture with a DNA stain; and measuring simultaneously the intensity of the DNA stain as a measure of the total cellular DNA and the halodeoxyuridine incorporated as a measure of DNA synthesis.

29 ENERGY PLANNING AND POLICY

38076 (GAO/RCED—86-63) Chemical data. EPA's data collection practices and procedures on chemicals. (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). Feb 1986. 39p. US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877. File Number TI86901391.

Report to the Congressional Requesters.

EPA's major data-gathering authority provided under four environmental acts was reviewed including: the types of data that EPA collects to support its regulatory decisions (i.e., health, exposure, and emissions data); and EPA's verification efforts to assure the accuracy and reliability of the data it collects. To identify EPA's major data-gathering authority, we performed legislative reviews of each of the four environmental acts. We then discussed this area with EPA officials in charge of the various program offices that use EPA's data-gathering authority in performing their regulatory missions. Further, we discussed our legislative review findings with our Office of General Counsel.

2901 Energy Analysis And Modeling

REFER ALSO TO CITATION(S) 37382, 38168

38077 (LIU-TEK-LIC—1985-20) Forest sector models. Vaerbrand, P. (Linkoeping Univ. (Sweden). Dept. of Mathematics). Nov 1985. 126p. (In Swedish). (LITH-MAT-R—85-17; LITH-MAT-R—83-19; LITH-MAT-R—85-16). NTIS (US Sales Only), PC A07/MF A01. File Number DE86770100.

In this thesis we consider problems within the forest sector. The thesis consists of three separable papers, all using quantitative methods and mathematical programming in the field of forestry planning. A simplified version of the world bank model is presented in paper number 1. The model describes an approach to economic planning in the forestry and forest industries sector of a nations's economy. In paper number 2 we present an energy transportation model, which describes the allocation of regional energy resources. It is a special type of multicommodity flow problem, where a commodity at an intermediate industry is converted into several new commodities, in given proportions. A small real life problem is solved using a penalty function technique. Finally paper number 3 discuss an alternative solution procedure for the model presented in paper number 2. Here we instead use the augmented Lagrangean technique. The resulting nonlinear network flow problem is solved by using the Frank-Wolfe algorithm. Comparisons with the penalty function technique will also be made.

38078 (NP—6752140) Maritime energy. Conditions for physical planning. Pedersen, T. (Statens Planverk, Stockholm (Sweden)). 14 Mar 1984. 101p. (In Swedish). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752140.

Various energy systems lay claim to oceans and coastal areas. This means siting of wind power plants, wave power plants and biomass plantations which in its turn will create problems of physical planning. The study deals with the state of the art concerning the species of energy, their environmental effects and impact of other participants of the utilization of ground and water. The development of methods for the treatment of energy species in physical planning is presented. Proposals for legislation and other procedures are made.

38079 **(NP—6752496) Expenditure system for energy planning.** Roedseth, A. (Oslo Univ. (Norway). Sosialoekonomisk Inst.). Jan 1983. 51p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86752496.

An attempt is made at integrating important ideas from partial studies of the household demand for energy (or fuels) into the complete systems framework. Consumers differ because they have got different heating technologies and different total expenditures. The latter has an impact on their (discrete) decision on whether to have a car or not. The households adjust their heating technologies only gradually over time. Individual demands are aggregated explicitly into total demands without assuming a representative consumer. The model is estimated on Norwegian macro data assuming the indirect utility function corresponding to the Quadratic Expenditure System and CES household production functions. The empirical results differ from other studies and should be taken with a considerable amount of scepticism. But they show some of the usefulness of the approach provided one can find more suitable functional forms. 36 references.

38080 **(Risoe-M—2553) Energy survey in Zambezi. Report from a study in Zambia - 1985.** Christensen, J.M. (Risoe National Lab., Roskilde (Denmark)). Oct 1985. 116p. NTIS (US Sales Only), PC A06/MF A01. File Number DE86752096.

The report presents the results and experiences from a field study in Zambia. The energy situation is described in detail. Energy consumption is analyzed by end-use and source. The supply situation for the different sources - firewood, charcoal, kerosene and electricity is presented and the available local and renewable resources are outlined. The household sector is divided into subsectors and the relation between income level and the choice of energy source is studied in detail.

38081 **(STEV—1985-10) Energy survey. Forecasting 1984-1990.** (Statens Energiverk, Stockholm (Sweden)). Nov 1985. 118p. (In Swedish). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752271.

The consumption of energy by industries, transportation, dwelling, service etc. is dealt with. Electric power and district heating is analysed and the origin of fuel supply is reported. Energy balance and price sensitivity concerning reduced oil prices are commented on. Forecasting is related to earlier changes and to energy policy. The actual international market is characterized by excess of offerings of oil, coal and gas. The estimate of the available nuclear power production by 1990 is revised. Consumption of oil will be reduced by use of coal, natural gas and indigeneous fuels and good house-keeping. (G.B.).

38082 **Quantifying uncertainty in energy model forecasts.** Ford, A.; Mckay, M.D. (Analysis and Assessment Division, Los Alamos National Laboratory, Los Alamos, NM). *Energy Systems and Policy;* 9: No. 3, 217-248(1985).

In this paper we demonstrate a method of quantifying uncertainty in energy model forecasts. Our demonstration makes use of sensitivity testing procedures that have been developed and tested over the past four years and that have been used in the analysis of several different types of mathematical models. The demonstration uses a medium size energy model that has been developed for the analysis of electric utility issues at the Department of Energy. Our purpose is to show that statistically interpretable confidence bounds on model forecasts can be established to quantify the parameter uncertainty of model forecasts.

38083 **Indianapolis technical innovation program: program results. Final Report.** Waltz, E.W. Indianapolis, IN; Aerospace Research Applications Center (1984). 42p.

A technical innovation program conducted by the City of Indianapolis to solve City operational programs, reduce costs, and improve service productivity is discussed. Program objectives are listed, and include: to execute all program activities within the regular decision-making and budgeting processes of the City government; and to subject the program plans, budget, and results to a review and evaluation by the City-County Council. During the first year of the program, a combustion engineering analysis of the City's waste sludge incinerator operations was performed; the analysis formed the technical basis for a pilot project to demonstrate how a new operating technology could reduce fuel consumption and improve the incinerator's efficiency. Indianapolis achieved a fuel savings of about $800,000 per year, and also significantly reduced particulate emissions.

2902 Economics And Sociology

REFER ALSO TO CITATION(S) 37358, 37379, 37382, 37383, 37385, 37754, 37756, 37772, 37817, 38134, 38921

38084 **(DOE/ER/64780—T1) [Partnership for energy accounting: taxpayers and students in correctional education]. Progress report, March 22, 1986-June 13, 1986.** (Unified Industries, Inc., Springfield, VA (USA)). 19 Jun 1986. Contract FG01-84CE64780. 8p. NTIS, PC A02/MFA 01; GPO Dep. File Number DE86011745.

Reluctance by states (Nebraska, New York, Texas, Florida, Iowa) to use assistance from prison vocational education programs has led grantees to go directly to correctional facilities in New York. (PSB)

38085 **(ORNL/TM—9429) Regional forecasting with the statistical analysis system.** Ray, J.J.; Vogt, D.P.; Westley, G.W. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 110p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86011374.

This paper presents a simplified forecasting technique readily available for use as needed. The technique while primarily designed to prepare current revisions of regional projections of economic time series similar to OBERS, also may be used to develop estimates of current conditions based on the latest reported national data. The technique can provide both consistency and flexibility in updating and projecting regional economic time series. The approach is designed to use the powerful data management and statistical software available in the Statistical Analysis System (SAS), minimizing the analysis and programming effort required. The framework developed for the projections is a data driven system. This approach provides flexibilty to the user in terms of variables and sectors for which projections can be made in specific applications. Additionally, once the basic historical series are defined, various aggregations of sectoral or regional detail can be developed. The approach provides, in one computer program, data preparation, equation estimation, and time-series projections. The historical and projected data series are preserved as well defined SAS data sets, allowing considerable flexibility in developing descriptive data reports to meet project needs, as well as in evaluating the estimation process and reviewing the reasonableness of the projections developed. An example regional forecast is generated and discussed in the report to illustrate how the system can be used to review the reasonableness of a projection series. 7 refs., 11 tabs.

38086 **(PNL-SA—13706) Approaching the market with new technologies.** Mohler, B. (Pacific Northwest Labs., Richland, WA (USA)). Jan 1986. Contract AC06-76RL01830. 13p. (CONF-860303—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011105.

From 13. annual energy technology conference and exposition (ET '86); Washington, DC, USA (17 Mar 1986).

Market acceptance of a new product/technologies is related to a number of factors. Some of these include: the complexity of the product/innovation - the more complex the more difficult market acceptance will be; the degree of newness - the newer the product is in either form or function, the more difficult market acceptance will be; the fit with consumer needs/desires - the better the fit, the earier market acceptance will be; and the presence of substitutes - the more substitutes, the more difficult market acceptance will be. An accurate and complete understanding of both one's consumers and markets will enable the commercializer to assess each of this adoption elements and develop appropriate and effective market strategies. In many cases management, or the commercializer, dose not have accurate or complete perceptions about consumers or the market. And while managerial experience and judgment are required in new product decision making, market research can sharpen perceptions and add important information and insight

to the decision process. Two studies are discussed below which illustrate this point. The first was conducted by Owens-Corning Fiberglas and the second by RMH Research, Inc., for Battelle, Pacific Northwest Laboratory and the Bonneville Power Administration.

2903 Environment, Health, And Safety

REFER ALSO TO CITATION(S) 37470, 37503, 37529, 37530, 37536, 37537, 37542, 37548, 37555, 37556, 37562, 37571, 37573, 37574, 37576, 37580, 37581, 37582, 37596, 37634, 37638, 37666, 37667, 38085, 38098, 38101, 38102, 38107, 38110, 38793, 38809, 38815, 38851, 38857, 38858, 38884, 38886, 38920, 38957

38087 **(CONF-860803—2) Two-phase framework for acid deposition science-policy decisions.** Lazaro, M.A.; Streets, D.G.; Surles, T. (Argonne National Lab., IL (USA)). 18 Dec 1985. Contract W-31-109-ENG-38. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007506.

From 7. world clean air congress and exhibition; Sydney, Australia (25 Aug 1986).

Policy decisions on most issues of public or private concern are routinely made in light of uncertainties in knowledge. Ample precedent exists for major far-reaching decisions on environmental problems of significant economic and societal importance, even though large uncertainty existed about the chain of causation. Many of these decisions were made on the basis of evidence that was far less convincing or certain than the current evidence available on acid deposition. Wisdom in the development of policy requires objective and rational assessments of scientific, economic, and societal data and the integration of uncertainty in this data base into a decision framework. This paper provides an overview of uncertainty and risk as they pertain to acid deposition policy formulation. With this background a two-phase policy decision framework for implementing and evaluating control or mitigation options is presented. With this background, the uncertainty and risk issue is discussed, and a two-phased policy decision framework for implementing and evaluating control or mitigation options is presented. Phase I of the framework provides a set of commercially available, economically feasible, and administratively reasonable control measures for consideration in developing and implementing an interim near-term control strategy. After a sufficient period of time for strategy evaluation, new technology development, and continued research on the spectrum of acid deposition science issues, Phase II of the framework could be implemented. Phase II would involve the use of an integrated assessment methodology that incorporates uncertainty in evaluating the need for further control or mitigation measures and identifies alternative cost-effective measures that can be considered, if required, by decision makers.

38088 **(DOE/FE—0060) Environmental Program Plan.** (USDOE Assistant Secretary for Fossil Energy, Washington, DC. Office of Oil, Gas, Shale and Coal Liquids). Mar 1986. 59p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86011955.

This Executive Summary provides an overview of the Environmental Program sponsored by the Deputy Assistant Secretary for Oil, Gas, Shale and Coal Liquids (DAS/OGSCL), a strategy for dealing with the fossil fuel issue in the environment, and the state-of-the-art for understanding and solving associated environmental problems in terms of environmental research. The details of the environmental research activities, by program element and planned for the five-year period FY 1986 to FY 1990, are documented more specifically in the text. The role of DOE in fossil energy development, as well as its particular activities in environmental research to promote the acceptability of developing fossil technologies, is also discussed.

38089 (EPRI-CS/EA/EL—4480, pp 1.1-1.4) **Fire involving PCB transformers further regulations managing the risk.** Manger, H.C. (Baltimore Gas & Electric, MD). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Amendments to the 40 CFR regulations regarding PCB-containing transformers are discussed. Transformers which come under the new regulations defined, specific use-application situations are prohibited, and timetables for implementation are presented. Management strategies for the risks associated with transformer fires are outlined; costs associated with the fires are identified (among them, litigation, business interruption, cleanup, and sampling and analysis), and procedures to be followed in the event of a fire are outlined. 2 references.

38090 (EPRI-CS/EA/EL—4480, pp 2.1-2.2) **Sampling and analysis criteria used to evaluate the efficacy of polychlorinated biphenyl (PCB) destruction.** Smith, J.H. (Environmental Protection Agency, Washington, DC). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The US EPA Office of Toxic Substances (OTS) has the responsibility to negotiate demonstration conditions for, examine demonstrations for, and write permits for PCB destruction efficacy demonstrations. One of the key factors in evaluating the demonstration of PCB destruction efficacy is analysis of the treated and untreated PCB matrix. Sampling of a matrix must be representative of that kind of matrix and the distribution of PCBs in the matrix. Analysis includes the preparation of the sample for instrumental analysis, interpretation of instrumental data, and reporting of the results of the analysis. In many cases waste products from the process must also be analyzed, the specifications of waste product analysis depend on the proposed method of disposal. OTS officials use the results of the sampling and analysis from the PCB destruction efficacy demonstrations in making final decisions on PCB Disposal Permits. For original untreated material greater than 500 parts per million (ppm) disposal is incineration and for original untreated material between 50 ppm and 500 ppm disposal is in an approved PCB landfill. The regulation also allows alternative methods of disposal if those methods have been determined equivalent to incineration.

38091 (EPRI-CS/EA/EL—4480, pp 6.1-6.3) **Insurance industry and the PCB exposure situation.** Clarke, R.G. (McNeary Insurance Consulting Service, Charlotte, NC). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Insurance industry experience with pollution (toxic chemical, hazardous waste, environmental) claims and loss has prompted a wave of policy exclusions for these types of exposures. PCB is included in the insurance industry category of pollution exposure. In addition to property damage claims, insurers have been faced with many liability claims. Due to extensive clean up, EPA involvement, and the uncertainty of human exposure implications, accurate prediction of loss is nearly impossible. It is for these reasons that insurers are excluding pollution related risks from current policies. Lack of insurance leaves PCB owners financially vulnerable, and requires that PCB managers play a more significant role in corporate risk reduction. PCB owners must become even more active in eliminating and controlling PCB risks in order to preserve financial integrity and avoid catastrophic loss situations. PCB elimination and the prospect of entirely non-PCB systems is the most prudent and reasonable alternative today.

38092 (EPRI-CS/EA/EL—4480, pp 6.12-6.15) **Managing economic risks due to electrical equipment containing PCBs: analytical tools to support utility decisions.** Amaral, D.A.L.; Boyd, D.W.; Cohan, D.; Johnson, M.S.; Wilson, D.S. Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The PCB Economic Risk Management Model (ASK) and the Contaminated Oil Economic Risk Management Model (COIL) are decision support tools designed to help utility personnel manage equipment containing or contaminated with PCBs. The models provide techniques for comparing alternative strategies in terms of equipment costs and the costs of potential incidents such as fires and spills. Comprehensive analyses can be carried out quickly and

efficiently, comparing different management options in terms of direct costs and costs due to incidents. Uncertainties in incident occurrence, severity, and cost may be accounted for explicitly. In addition to serving as a useful analytical aid, ASK and COIL can help utility personnel communicate with top management, regulators, and public groups about key insights from the analyses. The implications of alternative viewpoints and opinions can be tested and displayed quickly and easily, thus facilitating discussion and consensus building on difficult PCB management issues. 2 figures.

38093 (EPRI-CS/EA/EL—4480, pp 6.16-6.19) **Transformer/Capacitor Risk Management Model: TRIM.** Boyd, D.W.; Cohan, D.; Wilson, D.S. Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The Transformer/Capacitor Risk Management (TRIM) model is described. TRIM has been developed to facilitate analyses of alternative utility actions and regulatory policies involving electric equipment containing PCBs. Analyses performed using TRIM can provide a basis for improved understanding and insight into the costs and benefits of alternative actions. TRIM includes a detailed structural model and a flexible decision tree allowing explicit representation of key uncertainties. The primary uses envisioned for TRIM are to assist in the evaluation of regulatory policy options at the national, regional or local levels, and to assess the possible health risks at an individual utility due to the use of PCB equipment. TRIM has been used the Utility Solid Waste Activities Group to carry out a detailed analysis of potential risks due to fires involving PCB transformers. The analysis assessed potential health risks associated with incidents involving utility-owned askarel transformers, and evaluated a set of alternative regulatory policy options designed to mitigate the risks. 2 figures.

38094 **(OEFZS—4342) Developments and trends in environmental protection.** Cabela, E. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H.). Dec 1985. 27p. (In German). (NU—18/85). Oesterreichisches Forschungszentrum Seibersdorf GmbH .

The report gives a short review of the development of environmental problems and draws attention to the actual and future main areas of the global environmental hazards. Some aspects of possible strategies and technological solutions for environmental protection and restoration are being discussed. (orig.).

38095 **(PB—86-193679/XAB) Performance of RCRA (Resource Conservation and Recovery Act) Method 8280 for the analysis of dibenzo-p-dioxins and dibenzofurans in hazardous-waste samples.** Ballard, J.M.; Vonnahme, T.L.; Nunn, N.J.; Youngman, D.R. (Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV (USA)). May 1986. 96p. NTIS, PC A05/MF A01.

Further evaluation of RCRA Method 8280 for the analysis of chlorinated dibenzo-p-dioxins and dibenzofurans has been performed. The Method has been modified to enable the quantitation of total tetra- through octa-chlorinated dioxins and dibenzofurans and has been applied to six different sample matrices derived from industrial polychlorophenol sources and also to fly-ash, still-bottom, and Missouri soil samples. An interlaboratory validation of the Method has been conducted in two phases: Phase I required the analysis of spiked and unspiked clay and sludge samples for certain specified analytes, and Phase II required the analysis of 10 samples of soil, sludge, fly-ash, and furans. Method detection limits of (13)C12- labeled polychlorinated dioxins and dibenzofurans in seven matrices have been determined. In order to propose the most effective procedure, a comparison was made of the Contract Laboratory Program carbon column cleanup (without backflush) with the backflush procedure used in the proposed RCRA Method.

38096 **Use of energy scenarios in addressing the CO_2 question.** Rotty, R.M.; Reister, D.B. (Oak Ridge Associated Universities, Oak Ridge, TN). *Proceedings, Annual Meeting, Air Pollution Control Association;* 3: 1-15(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

The paper discusses difference in the CO_2 resulting from various scenarios presented, which result only from changing the cost of electricity generated from fossil and nonfossil energy supply systems. Even with heavy emphasis on nonfossil sources the CO_2 concentration will rise to values that are almost certain to change the global climate by significant amounts. To produce a lower CO_2 emissions scenario, the assumptions about the global population, world gross product, global energy demand, and any of a number of other variables could be revised downward. The point being made in this analysis is that without any change in these factors, the simple shift from one fuel source to another can have major impacts on the resulting atmospheric CO_2 concentration, but to avoid the problem completely, social aspirations for the world population must also be changed. Even though much can be accomplished by shifting to alternative energy systems, it remains true that effective control on the rates of CO_2 growth a century from now must begin with planning and action in the very near future.

2904 Natural Resources

38097 **(LiU-TemaV-RB—85-10) Water quality and regional development. Contributions to the Swedish water conservation history of the last century with examples from the Motala River Basin.** Romaas, A.E. (Linkoeping Univ. (Sweden). Dept. of Water in Environment and Society). Feb 1985. 101p. (In Swedish). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752141.

The appearance of water quality problems are closely connected with the regional development. Increasing demand on water for industrrial and domestic use have caused severe water pollution problems. In the report different types of water quality problems are described and analysed in a historical perspective. In part I the development of water quality problems and the legal and administrative framework on national, regional and local level for the water conservation work are described. The time perspective is mid 19th century to 1980. In part II different tools for improvement of the water quality are described. Their practical applications and effects are analysed. Specially the development of drinking water standards and methods for water quality assessment and their applications are analysed. In part III special water quality investigations and water conservation applications in Motala River Basin are studied. Examples are: systems for water quality monitoring, effects of waste water treatment, location of pulp- and paperindustry, leakage of nutrients etc. In Appendix is given a brief list of public water conservation laws and regulations. 60 refs.

38098 **A theory of forest dynamics: The ecological implications of forest succession models.** Shugart, H.H. New York, NY; Springer-Verlag (1984). 278p. Springer-Verlag New York, Inc., 175 Fifth Avenue, New York, NY 10010.

This book is a synthesis of what has been learned about ecological succession from the process of developing the models for the various systems which typically consisted of starting with the FORET model (an Appalachian deciduous forest). Modifying, testing, and applying such a model is the core of this work. Contents, abridged: Forest succession. Computer models of forest succession. Patch dynamics in forested mosaics. Categories of dynamic landscapes. A theory of forest dynamics. Index.

2905 Research, Development, Demonstration, And Commercialization

REFER ALSO TO CITATION(S) 37709, 38662, 39298

38099 **(DOE/EIA—0204(86/03)) EIA publications: new releases. Publications released, May-June 1986.** (USDOE Energy Information Administration, Washington, DC). 27 Jun 1986. 37p. NTIS, PC A03/MF A01; 1 - GPO; GPO Dep. File Number DE86012687.

The document highlights the newest available Energy Information Administration (EIA) publications and upcoming reports. It includes news about EIA as well as many other items of special interest. (PSB)

38100 **(PB—86-190428/XAB) Selected papers from the annual meeting of the British Association for the Advancement of Science held at Strathclyde, Scotland on August 26-30, 1985. Section A.** (British Association for the Advancement of Science, London). 1985. 127p. NTIS, PC A07/MF A01.

Topics include: The importance of remaining curious (Presidential address by Sir Hans Kornberg); What happens when things get very cold; Trends in energy demand and costs; Safety standards applied to radioactive waste disposal; Management of radioactive wastes; Recent developments in acid rain research; Choosing winning R&D projects; New technology development in the U.S.; Detecting earthquakes and nuclear explosions; and The Strategic Defense Initiative.

38101 **(PNL—5880) Inventory of current environmental monitoring projects in the US-Canadian transboundary region.** Glantz, C.S.; Ballinger, M.Y.; Chapman, E.G. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 288p. NTIS, PC A13/MF A01; 1; GPO Dep. File Number DE86011717.

This document presents the results of a study commissioned to survey and summarize major environmental monitoring projects in the US-Canadian transboundary region. Projects with field sites located within 400 km (250 mi) of the border and active after 1980 were reviewed. The types of projects included: ambient air-quality monitoring, ambient water-quality monitoring, deposition monitoring, forest/vegetation monitoring and research, soil studies, and ecosystem studies. Ecosystem studies included projects involving the measurement of parameters from more than one monitoring category (e.g., studies that measured both water and soil chemistry). Individual descriptions were formulated for 184 projects meeting the spatial and temporal criteria. Descriptions included the official title for the project, its common abbreviation, program emphasis, monitoring site locations, time period conducted, parameters measured, protocols employed, frequency of sample collection, data storage information, and the principal contact for the project. A summary inventory subdivided according to the six monitoring categories was prepared using a computerized data management system. Information on major centralized data bases in the field of environmental monitoring was also obtained, and summary descriptions were prepared. The inventory and data base descriptions are presented in appendices to this document.

2906 Nuclear Energy

REFER ALSO TO CITATION(S) 37635, 37638, 38886

38102 **Progress in conversion of the Department of Energy nuclear standards to national consensus standards.** Cooper, W.L. (Oak Ridge National Lab., Oak Ridge, TN 37831). pp 3 of Proceedings of the ASME winter annual meeting. New York, NY; American Society of Mechanical Engineers (1984). (CONF-841201—). Contract AC05-84OR21400.

From ASME winter annual meeting; New Orleans, LA, USA (9 Dec 1984).

The conversion policy, with respect to the development and use of standards in the Department of Energy (DOE) programs concerned with maintaining and developing the nuclear option for the civilian sector, is embodied in a Standards Program Policy Order issued in 1980. The DOE has recognized that the national consensus standards process is the most appropriate tool for achieving the legitimate goal of the nuclear programs, which is to make nuclear energy a safe, reliable, and cost-effective means of supplying the nation's energy needs. We will continue to submit DOE program standards to national consensus standards organizations for consideration as a possible basis for a consensus standard writing effort. At present, 24% of the DOE's program standards have been accepted by national consensus standards organizations and are in the conversion process.

2908 Waste Heat Utilization

REFER ALSO TO CITATION(S) 37817, 38132

2910 Conservation

REFER ALSO TO CITATION(S) 38084, 38149, 38152, 38167

38103 **(PB—86-182359/XAB) Innovative research and development opportunities for energy efficiency. Final report.** (National Research Council, Washington, DC (USA). Commission on Engineering and Technical Systems). 1986. 131p. NTIS, PC A07/MF A01.

The study was undertaken in response to a request from the U.S. Department of Energy (DOE) to examine the role and process of innovation in energy conservation research and development. In particular, DOE desired a report that would identify highly innovative energy research opportunities that could be leveraged with a small budget by the Energy Conservation and Utilization Technologies Program (ECUT), expecially with regard to the Innovative Energy Conservation Concepts Program (IECC). The purpose was to provide an up-to-date review of opportunities for, and approaches to, innovative research as a contribution to the planning processes in ECUT/IECC. The report reviews opportunities to conduct innovative research in a variety of R&D fields, the results of which could increase the energy efficiency of a product or function. The emphasis is on the technology, and on the R&D opportunities that the Committee believes merit support. In addition, the report addresses the problem of formulating appropriate research strategies and methods to bring forward additional R&D ideas, attract competent researchers, and improve the overall proposal selection process.

2920 Supply, Demand, And Forecasting

REFER ALSO TO CITATION(S) 37468, 38085

38104 **(NP—6752102) Energy plan for Qaqortoq/Julianehaab.** (Arbjedsgruppen Vedroerende Udarbejdelse af en Energiplan for Groenland, Copenhagen (Denmark)). Jun 1985. 171p. (In Danish). NTIS (US Sales Only), PC A08/MF A01. File Number DE86752102.

The Greenland Assembly accepted a general energy supply plan until the year 2000 based on 50% hydro power, 25-30% imported coal and the remaining 20-30% on oil. A planning committee for Qaqortoq/Julianehaab district considered 5 supply models: the oil model, the imported coal model, the domestic coal model, hydroelectric power optimum model and a combined hydropower-oil heating model. Environmental aspects, investment requirements and fuel import problems are discussed in detail. Comparison of profitability of the five models proves the hydro power models to be the most promising, but investment required for the transition from oil to hydroelectric power will give only about 7% interest of the increased capital. The working committee recommends energy supplies in Qaqortoq/Julianehaab based on coal and oil provided that Narsaq shares the expenses of coal storage and transport. The model will be revised in connection with further construction of a new diesel power plant.

38105 **(SLU-ISK—163) Energy in Dalecarlia in 1990 - calculations of energy sources utilized in the heating plants.** Bjoerklund, A. (Swedish Univ. of Agricultural Sciences, Garpenberg. Dept. of Operational Efficiency). 1985. 83p. (In Swedish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752143.

This report presents the results from a pilot study of the future energy consumption in the county of Kopparberg. The objective of the study was to illustrate how assessible raw materials could best be utilized and to find a solution what would give the lowest possible energy costs to the entire county. Coordination across township boundaries is thus a leading theme of the study. The energy sources considered in the study are forest fuel, peat, household waste and oil. The forest industry's requirements of in-

dustrial wood and forest fuel are included. The results of the study can be summed up in the following five points: - There are considerable differences in the choice of fuel, depending on geographical location. Forest fuel is the best choice for heating plants situated in townships northwest of an imagined line going through Falun, Borlaenge and Ludvika. Peat is the best choice of main energy source for the rest of the county. - There was not a single case where oil could compete, successfully, with the domestic energy sources. - Forest energy is, under certain circumstances, the most economical energy source. It is limited by supply and future environmental restrictions. - The most important prerequisite for large scale consumption of forest fuel is the extent to which the existing railroad terminals are equipped to handle tree sections method in loggings. - The strong connection between forest energy and handling of industrial wood is shown. The forest fuel supply is dependant on the forest market conditions and on the portion of wood harvested in thinnings.

38106 **(TKK-F-A—504) Optimization model for the Finnish energy supply system - KETO. General description.** Mannonen, M.; Routti, J.T.; Pirilae, P. (Helsinki Univ. of Technology, Otaniemi (Finland). Dept. of Technical Physics). Mar 1983. 18p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752119.

A long term planning model for a national energy supply system is presented. The model KETO is a dynamic multiperiod linear programming model built specifically to describe the Finnish energy system. The energy system is described as a network of energy flows from the primary energy sources through various conversion and transmission steps to the final energy users. The forms of energy considered include all major fuels, other sources of primary energy, electricity and heat. Among the conversion sectors are included fuel refineries, electricity and heat production separately and using cogeneration as well as the heating equipment of individual houses. Final energy consumption is given exogeneously, but can be modified by conservation measures. The model has been realized using a general purpose, computer manufacturer supplied linear programming - matrix generator package. Therefore even major modifications to the structure of the model can relatively easily be incorporated making the study of a large variety of problems possible.

2930 Policy, Legislation, And Regulation

REFER ALSO TO CITATION(S) 37452, 37463, 37635, 38079, 38096, 38799

38107 **(GAO/RCED—86-81FS) Hazardous waste. Adequacy of EPA attorney resource levels.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). Jan 1986. 19p. General Accounting Office, PO Box 6015, Gaithersburg, MD 20877. File Number TI86901393.

Fact sheet for the Chairman, Subcommittee on HUD-Independent Agencies, Committee on Appropriations, United States Senate.

This fact sheet summarizes the information on the adequacy of the Environmental Protection Agency's (EPA's) regional attorney resources to enforce the Comprehensive Environmental Response, Compensation and Liability Act (commonly known as Superfund) and the Resource Conservation and Recovery Act (RCRA), and to defend EPA in lawsuits under these Acts. In addition, information on EPA's fiscal year 1986 budget development for these activities is provided.

38108 **(GPO—4-080) 1985 science and technology posture hearing with the Director of the Office of Science and Technology Policy. Hearing before the Committee on Science and Technology, 99th Congress, First Session, No. 1.** (Committee on Science and Technology (U.S. Congress. House), Washington, DC). 1985. 77p. GPO.

Presidential Science Adviser Dr. George Keyworth, Director of the Office of Science and Technology Policy, gave his annual (1985) report on US Science and Technology posture at a hearing of the Committee on Science and Technology of the US House of Representatives (99th Congress) on 5 Feb. 1985. He spoke of critical choices in three areas, i.e., how to reduce nuclear weapons, thereby to enhance the national security, how to ensure US technological superiority in the face of rapidly growing international competition, and how to accomplish the foregoing while reducing government deficits. US government support for Research and Development will total $60 billion this year, $20 billion of which are for non-defense programs, and $8 billion for basic research. He emphasized the importance of the latter to the nation's economic wellbeing, and the need to make every research dollar count in the face of rising costs and soaring deficits. Dr. Keyworth urges aggressive US efforts to maintain its world leadership in science and technology.

2940 Fossil Fuels

REFER ALSO TO CITATION(S) 37358, 37379, 37382, 37383, 37393, 37466, 37467, 37468, 37469, 37469, 37503, 38088, 38104

38109 (CONF-8509275—, pp 259-269) **National energy administration - contributions and plans for development of peat land.** Palmberger, B. (National Energy Administration, Stockholm, Sweden). 1985. NTIS (US Sales Only), PC A17/MF A01. File Number DE86752282.

From Symposium on peat and the environment; Joenkoeping, Sweden (17 Sep 1985).

The peat R and D program covers the development of knowhow and technology for the production of peat fuels, treatment and conversion systems and storage and transport methods. In Sweden, peat was used as a fuel in the past, but the use of peat as a fuel ceased in Sweden in the 1950s. When interest was aroused again in the 1970s, production had to be built up afresh. The trend only got under way in the 1980s, mainly as a consequence of government backing for peat producers, machine manufacturers and peat users. Peat provided about 0.8 TWh of Sweden's total energy consumption in 1984. Since the end of the 1970s, Swedish development efforts have been aimed at developing year-round peat winning technology, and some methods have now been tested at the experimental stage. Urgent development projects for the period 1984/1985-1986/1987 involve the developing of machines and equipment that make it possible to mine peat during the major part of the year. Efforts during the period are divided into the following areas: Knowledge of peat. The National Energy Administration will support development of knowledge. Backing will be shared among analysis, water removal and environmental studies. Peat technology. This area includes backing of methods for surface extraction, full depth extraction, in situ extraction and peat processing. Fuel conversion. Indigenous energy raw materials are converted into liquid and gaseous fuels. Combustion technology. Combustion in furnaces for the production of steam and heat in power stations, combined heating and power plants and hot water and heating plants.

38110 **Greenhouse gases in the atmosphere: What do we know.** Marland, G.; Rotty, R.M. (Oak Ridge Associated Universities, Oak Ridge, TN). *Proceedings, Annual Meeting, Air Pollution Control Association;* **3**: 1-17(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

In September 1983, the U.S. Environmental Protection Agency released a major study on CO_2 in which they took a look at whether specific policies aimed at limiting the use of fossil fuels would prove effective in delaying temperature increases over the next 120 years. Of the earth surface warming envisioned by the EPA in 2040 approximately one-third was due to the increase in other greenhouse gases. To understand a complex system it is often necessary to first understand the individual parts of the system. In this case the individual greenhouse gases must be analyzed and the sources and sinks for each species and its chemical behavior identified. This paper reports on a study that started with a single gas nitrogen, and attempted to pull together what is known about it. This serves to illustrate the type of approach the authors feel is appropriate.

2950 Hydrogen And Synthetic Fuels

REFER ALSO TO CITATION(S) 37695, 37707, 37708

2960 Electric Power

REFER ALSO TO CITATION(S) 37466, 37839, 37840, 37852, 37853, 37872, 37935, 37976, 37977, 38206, 38815

38111 **(DOE/BP/36696—1) Marketing electricity to industrial consumers: a study of Pacific Northwest industries.** (Northwest Economic Associates, Vancouver, WA (USA)). May 1986. Contract AI79-85BP36696. 317p. NTIS, PC A14/MF A01; 1; GPO Dep. File Number DE86012472.

Purpose of this study is to examine factors relating to electricity use by the high energy-use industry groups of the Pacific Northwest (primary metals, chemical products, pulp and paper products, wood products, irrigated agriculture, and food products) from several perspectives. The slowdown in US economic growth is examined in the context of a review of trends in the US manufacturing sector. A cross-regional analysis is provided to give perspective on how the Pacific Northwest compares to other US regions with respect to employment levels, industrial output, and regional and industrial energy use. Economic growth projections for the Pacific Northwest are reviewed. The utility perspective focuses on electricity costs as a factor influencing new industrial growth in the region. The perception by economic development agencies of the importance of electricity rates as a factor promoting regional growth is documented. Electricity marketing efforts implemented by BPA and other utilities are reviewed. Recent production and employment trends for selected high energy-use industrial groups in the Pacific Northwest are documented. Response to electricity rates within the high electricity-use industry groups is examined.

38112 **(EPRI-EM—3287-CCM-Rev.2) LOADSIM version 2: program documentation and user's manual. Revision 2.** Grimsrud, G.P. (ECC, Inc., San Jose, CA (USA)). Jun 1986. 403p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920354.

This report provides a detailed program documentation and user's manual for LOADSIM, a computer program designed to assist utilities in planning residential load management strategies. LOADSIM simulates in detail the impacts of residential customer load management technologies on utility system load shapes. It can be used by utilities: to experiment with a large number of load management technologies; to quickly evaluate load management options; to estimate the long-term impacts of load management strategies; and to facilitate load management data transfer between utilities. LOADSIM has been verified by field data from four utilities - Detroit Edison Co.; Southern Company Services, Inc., in conjunction with Gulf Power Co.; United Power Association; and Pacific Gas and Electric Co. The code is available now to EPRI member utilities. This report is intended to provide utility users assistance in developing input data bases and applying LOADSIM in load management projects. A more general description of the model is presented under a separate cover in the final report, Development and Demonstration of a Load-Shape Simulation Model (LOADSIM) for Evaluating Customer Load Management Technologies (EPRI Final Report EM-3249).

38113 (EPRI-EM—4393, pp 1.1-1.13) **Data needs for end-use planning in the commercial sector.** Wharton, J. (Electric Power Research Institute, Palo Alto, CA). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

Technicians, programmers, clerks, and other whose primary job is producing, distributing and storing information have grown from 17% of the labor force in 1950 to over 65% today. Utilities see this transformation as the steady increase in the importance of the electric loads, particularly peak loads, of new commercial buildings, such as offices, medical facilities and restaurants. There is clearly a great potential for demand-side management programs to shape new and existing commercial loads to reduce utility costs and increase customer satisfaction. To realize this potential, utilities must have the information and tools to target for change specific end uses, such as lighting, cooling or heating. An integrated research effort to develop a generic tool and to demonstrate its applicability is described.

38114 (EPRI-EM—4393, pp 2.1-2.10) **Description of Sierra Pacific Power activities.** Caldwell, R. (Sierra Pacific Power Corp., Reno, NV). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

Sierra Pacific Power Company is a part of Sierra Resources, a holding company. Sierra serves approximately 200,000 customers in Northern Nevada and parts of Northeastern California. Recent demands were 708 MW in the Summer and 704 in the Winter. Sierra has a 70% annual load factor. Approximately 80% of Sierra's sales are in Northern Nevada, with the balance in Northeastern California. Senate Bill 161 went into effect July 1, 1983, in Nevada. This bill, which is commonly referred to as The Resource Planning Act, led to General Order 43. G.O. 43, adopted in final form in June of 1984, is the Nevada Regulation approved by the Public Service Commission in accordance with Senate Bill 161. This regulation contains broad and stringent requirements for forecasting and resource planning. The regulation is described.

38115 (EPRI-EM—4393, pp 3.1-3.5) **Overview of ELCAP.** Stokes, R.A. (Pacific Northwest Lab., Richland, WA). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—). Contract AC06-76RL01830.

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

The End-Use Load and Conservation Program (ELCAP) is a multi-year effort sponsored by the Bonneville Power Administration (BPA) to better understand the energy performance and conservation potential of buildings in the Pacific Northwest. ELCAP serves as an umbrella structure for a number of programs designed to meet specific research goals. Prominent among these are programs designed to evaluate the effects of the Northwest Power Council's proposed Residential Standards Demonstration Program (RSDP), to characterize auditing procedures in commercial buildings [i.e., BPA's Commercial Audit Program (CAP)], and to investigate the effects of conservation incentives and retrofit weatherization [i.e., BPA's Purchase of Energy Savings Program (PES)]. A number of structures will be subjected to detailed end-use metering in support of these programs. In addition, large samples of residential and commercial buildings in the Bonneville service territory, not participating in any of the specific programs, will be metered. These data collection efforts, while sharing a common technology and approach to data acquisition and management, have distinct research plans with different schedules, staff, and equipment requirements. The separate projects which comprise ELCAP are briefly described, and the five subsequent papers which detail the project metering experience to data are introduced.

38116 (EPRI-EM—4393, pp 4.1-4.4) **Commercial hourly end-use study at Seattle City Light.** Cleary, C. (Seattle City Light, WA). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

Seattle City Light is conducting a comprehensive study on commercial hourly end-uses of electrical energy. Even data collection methods had to be researched. The objectives of this project include: (1) describe energy consumption by end-use and by time for a variety of commercial and multi-family building types, identify cost-effective conservation strategies for each building type, (2) identify cost-effective conservation strategies for each building type, (3) implement conservation strategies in a sample of commercial and multi-family buildings and to measure performance, and (4) determine how variations in building characteristics and occupant usage patterns affect conservation potential. To accomplish these objectives, Seattle City Light decided that it was necessary to col-

lect end-use metered data. The first difficulty was to develop a reasonably low cost, yet accurate method of collecting the data. The data collection method is described.

38117 (EPRI-EM—4393, pp 5.1-5.16) **Review of the current status of commercial end-use load shape data.** McDonald, C. (Synergic Resources Corp., Bala-Cynwyd, PA). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

The increasing importance of end-use forecasting, conservation analysis, marketing, and demand-side planning has resulted in a need for accurate estimates of end-use load shapes. Yet little such data are available, due largely to the perception that these data are too expensive to collect. The status of end-use load shape data for the commercial sector in the electric utility industry is reviewed. The principal conclusions include: there is currently little accurate end-use load shape data for the commercial sector; end-use load shape data are important for marketing, demand-side planning, and forecasting; several utilities are conducting end-use metering efforts: metering strategies have been developed so that it is economically feasible to collect hourly end-use load data; the statistical and engineering simulation techniques that are used to estimate end-use load shapes are in need of calibration and validation using actual load data; and the initial data from end-use metering efforts have provided valuable insights into how electrical energy is used in the commercial sector.

38118 (EPRI-EM—4393, pp 6.1-6.20) **Application of model based sample design for the Pacific end-use metering project.** Wright, R. (Univ. of Michigan, Ann Arbor). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

Some of the work on planning the statistical design of Sierra's Energy Information Project is described. The paper contains three sections. Section 1 gives an overview of the Sierra sampling plans, using the office and restaurant classes as examples. Section 2 discusses some general principles of statistical sampling that have important implications for end-use metering projects. This section also outlines the model-based statistical sampling (MBSS) approach that was developed for designing load research projects. Section 3 returns to the specific application of these general principles and methods to Sierra's end-use metering project.

38119 (EPRI-EM—4393, pp 7.1-7.13) **Issues and approaches for designing commercial building samples.** Reiter, P.; Baker, M. (Baker, Reiter and Associates, Seattle, WA). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

The discussion of sampling design and implementation in energy planning applications generally occurs in the context of a narrowly defined data collection effort. Such efforts are often undertaken to support a particular planning tool (e.g. collect data on a sample of residential structures to obtain appliance saturations for the load forecasting model). The other common situation is a data collection effort involving sampling which addresses a very specific question, e.g., estimate the hourly load shape for a sample of customers with heat pumps. In this context, sampling discussions have had a tendency to focus almost exclusively on issues related to the efficiency and reliability of the sample design. Specifically: minimum sample sizes needed to describe load within some level of accuracy, the introduction of efficiency through stratification, sample optimization, and requirements for generalizing to population. These issues are discussed.

38120 (EPRI-EM—4393, pp 8.1-8.6) **ELCAP instrumentation.** Schuster, G.J.; Tomich, S.D. Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

End-use electrical metering is a challenging experimental task, which places substantial demands on instrumentation. A well-designed data logger for end-use metering studies should have a number of characteristics: it should be sufficiently flexible, it should permit the acquisition of data at a variety of temporal resolutions, it should be reliable, maintaining its performance over extended periods in the field without requiring adjustment, it should be sufficiently inexpensive to permit metering of a large sample of buildings at reasonable cost, it should have nonvolatile solid state memory and permit the remote acquisition of data, it should permit measurements with an accuracy at least equal to that of utility-grade meters, and it should be capable of supporting a variety of instrumentation. Over the past few years Pacific Northwest Laboratory has developed a series of data loggers. The most recently completed logger, designed to meet these requirements, is currently being deployed in the End-Use Load and Conservation Assessment Program (ELCAP), and end-use metering study of 1000 residential and commercial structures in BPA's service territory. A functional description of the data logger is presented, describing both the main hardware components and the system's software.

38121 (EPRI-EM—4393, pp 9.1-9.15) **ELCAP: measurement plans and equipment installation.** Mazzucchi, R.P.; Sandusky, W.F.; Schuldt, M. (Pacific Northwest Lab., Richland, WA). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

Pacific Northwest Laboratory (PNL) will be installing metering equipment in approximately 200 commercial buildings in the Seattle, Washington area. This effort is one part of the End-Use Load and Conservation Assessment Program (ELCAP) that PNL is conducting for the Bonneville Power Administration (BPA). Under ELCAP various well-defined activities will be completed to ensure that all the metering equipment has been installed properly, functions in the desired manner, and provides accurate energy performance data. This last activity requires that a measurement plan be generated. Since experience with the collection of actual energy performance data from commercial buildings is limited to date, the measurement plan development procedures were evaluated in a set of pilot buildings prior to finalization. Precise documentation of how measurement plans are configured and implemented is essential to ensure adequate quality control. The measurement plan, important to the installation process in that it provides a road map to the installation contractor, is described.

38122 (EPRI-EM—4393, pp 10.1-10.15) **Instrumentation and data collection.** Finger, J. Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

Presentations made under several topic headings in the workshop are summarized. The paper is generally organized by topics and sequence, as presented in the workshop. While Sierra has dealt with all aspects of the planning and implementation of an end-use data acquisition project, the topics addressed at the workshop and in this paper are those assigned to Sierra by the workshop coordinator. This paper, thus, is not intended to address all aspects of an end-use data acquisition project. The major topics in this paper are: instrumentation, field installation, and data collection and management.

38123 (EPRI-EM—4393, pp 11.1-11.34) **Commercial building recruitment for the end-use load and conservation assessment program.** Mazzucchi, R.P.; Craig, S.N. (Pacific Northwest Lab., Richland, WA). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

Relations with building owners and tenants are crucial to the success of any monitoring project. This is particularly true when randomized sampling procedures are employed, wherein high participation rates are desirable to minimize possible bias. The ap-

proach and procedures employed by the End-Use Load and Conservation Assessment Program (ELCAP) to secure and maintain access to monitoring sites in the commercial sector are described. The ELCAP commercial sample in Seattle is targeted at 200 sites. Thirty of the sites are selected from a group of approximately 60 buildings constructed since 1981. The remaining 170 sites are apportioned to various building types based on an estimate of the share of the regional electrical load. Approximately 1000 candidate sites for this sample were randomly drawn from some 12,000 tax assessor records maintained by the City of Seattle on commercial parcels.

38124 (EPRI-EM—4393, pp 12.1-12.16) **Data acquisition and management.** Pearson, E.W. (Pacific Northwest Lab., Richland, WA). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

Any large-scale end-use metering experiment involves acquisition of a substantial quantity of data from a network of field stations over an extended period of time. Successful completion of such a project requires that several conditions are met. Data of good quality must be obtained from a high fraction of the experimental sites with few gaps in the time series records. These data must be verified and made available to analysts with a minimum of delay. It must be organized in such a fashion as to be readily accessible to analysts in a form which permits them to address issues related to the experimental goals. Finally, each of these conditions must be achieved at reasonable expense. Meeting these conditions is a particular challenge for ELCAP because of the very broad scope of the project. Among the complicating factors are the total size of the sample, number of measurements undertaken in individual structures, the fact that different measurement protocols are required for the various metering studies which compose ELCAP, and the logistical problems associated with the size of the Bonneville Power Administration service territory. These factors require development of a data acquisition and management system that is highly automated and reliable.

38125 (EPRI-EM—4393, pp 13.1-13.15) **Data verification in end-use metering.** Pearson, E.W.; Stokes, G.M.; Crowder, S. (Pacific Northwest Lab., Richland, WA). Jan 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920139. (CONF-850175—).

From EPRI end-use metering workshop; Seattle, WA, USA (15 Jan 1985).

End-use metering involves the collection of data on physical phenomena. It is thus subject to the same difficulties encountered in all experiments in the physical sciences, and requires the same attention to data quality that any properly conducted experiment should receive. The verification procedures adopted for ELCAP are described. Most of the emphasis is placed on verification techniques which are applicable to any end-use metering experiment, although the examples are drawn from ELCAP and thus depend on the metering equipment and data acquisition protocols employed in that project. The motivations for verification at various stages of an end-use metering project and the goals of verification procedures are discussed and several classes of procedures which can be used to meet verification needs described. A description of the implementation of the two major classes of verification on procedures currently employed in ELCAP is presented. The management approach to verification activities is outlined. Finally, an assessment of the verification processes is presented.

38126 (EPRI-EM—4616) **Impact of computer-integrated manufacturing on electricity end use. Final report.** Hunt, V.D.; Chittenden, T.R.; Patterson, O.D. (Technology Research Corp., Springfield, VA (USA)). Jun 1986. 182p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920350.

Industrial computer technology, changing load and power factors as well as clean power needs, will affect both producers and consumers of electric power. This study offers an early glimpse of the power use impacts that a shift in manufacturing methods will create.

38127 (EPRI-EM—4628) **Design of load-control experiments for the Athens Automation and Control Experiment.** Johnston, T.; Newton, B.; Smith, B.A.; Chan, M.L.; Grimsrud, G.P. (Minimax Research Corp., Berkeley, CA (USA); ECC, Inc., San Jose, CA (USA)). Jun 1986. Contract AC05-84OR21400. 120p. NTIS, PC A06/MF A01; 1 - Research Reports Center, Box 50490, Palo Alto, CA 94303; GPO Dep. File Number DE86012795.

The research assessed the load control experiments' design, examined the adequacy of the AACE load data monitoring strategy, developed preliminary experiments and developed analysis plans for the load control experiments' results. The volt/var and system reconfiguration experiments of the AACE were not examined in this project. The results of the experimental design assessment include the finding that the addition of end-use load monitoring will greatly enhance the load control experiments' worth, especially if the Athens data are to be used by other utilities. These analysis results led to the addition of end-use load data collection equipment in Athens. The report presents a detailed statistical model for assessing the adequacy of load data collection strategies, to ensure statistical validity of the experimental results. The model was developed on this project and applied to Athens in order to develop the required load monitoring sample size for these experiments. Sample sizes were developed for specified levels of statistical confidence, accuracy and load data sampling rates. This model facilitates data transferability to other utilities, since it defines a number of important parameters that may be considered in transferring the Athens data to other utilities.

38128 (LBL—21098) **Effect of conservation programs on electric utility earnings: results of two case studies.** Kahn, E.; Pignone, C.; Eto, J.; McMahon, J.; Levine, M. (Lawrence Berkeley Lab., CA (USA)). Aug 1984. Contract AC03-76SF00098. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012763.

This paper develops methods to measure the impact of conservation programs on electric utility earnings. The methods are applied to two case studies. Detroit Edison represents a case where impacts are unfavorable. This utility has "excess capacity" which is only made worse by conservation. Pacific Gas and Electric represents a case where conservation helps defer the need for new capacity. Even in this case, programs targeted at summer peak demand are more beneficial than those which save baseload energy. Conditions determining the earnings impact of conservation are complex, involving regulatory factors that are specific to individual utilities.

38129 (LITH-IKP-R—390) **Electric power demand of the industry - means of controlling the loads.** Bjoerk, C.; Karlsson, B.G. (Linkoeping Univ. (Sweden). Dept. of Mechanical Engineering). 28 Jun 1985. 67p. (In Swedish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86770099.

The following ways of controlling the load are described. - Using fuel oil for space heating and hot water, the potential of it being 10.3 TWh per year. - Heavy oils for paper and pulp industry cover 8.3 TWh which can be replaced by electric power during low loads. - Storage of energy will correspond to 270 MW for charging during low load and thus avoiding the effect of 40 MW during daytime. - Priority systems may reduce the demand by 550 MW. - Grain drying by electric power will increase the demand for August and September by 550 MW. - Manufacturing of chlorine and alkalis can be load controlled and will render 150 MW by reduced demand in winter time. - The storage effect of water towers can be used 1 hour, corresponding to 100 MW. The importance of heat capacity for applied load controlling and industrial power generated by back pressure is discussed.

38130 (PB—86-182276/XAB) **Issues in electric energy systems: a review of the DOE (Department of Energy) R and D program. Final report.** (National Research Council, Washington, DC (USA)). 1986. 86p. NTIS, PC A05/MF A01.

The Committee on Electric Energy Systems was established to review the need for research related to electric energy systems, and to review the U.S. Department of Energy's program in this area. The DOE's Electric Energy Systems program is directed

toward the power-delivery portion of a utility system, i.e., from the electric generator to the customer's meter. In order to gain a broad perspective and a better understanding of the issues, the committee organized a 2-day workshop. Based on the workshop, the committee established a schedule and plan for the remainder of the study. The main emphasis was to define and characterize an appropriate federal role in supporting R&D to help solve the technical problems of the electric power industry.

38131 **(UCID—20791) Cost trends for electric power generation 1979-1984.** Dezendorf, J.N. (Lawrence Livermore National Lab., CA (USA)). 19 Jun 1986. Contract W-7405-ENG-48. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012609.

This document presents the results of a statistical study of the capital that major US utilities have committed to plant and equipment between 1979 and 1984, and the percentage of operating expense that fuel cost now represents as compared to previous years. Some totals for the 31 companies are presented also.

38132 **Natural gas fired combined cycle generators: Dominant solutions in capacity planning[1].** Tabors, R.D.; Flagg, D.P. (Massachusetts Inst. of Technology, Lab. for Electromagnetic and Electronic Systems). *IEEE Transactions on Power Systems;* **PWRS-1**: No. 2, 122-127(May 1986).

Natural gas fired gas turbine combined cycle technologies are evaluated in a standard capacity planning model for the 6 EPRI Regional Utilities. Results indicate that GTCC technology dominates the optimal decision paths for 4 of the 6 regions studied. Further, the study concludes that the GTCC options offer minimal downside risk on price of gas, on operating conditions or on capital cost.

38133 **Managing the nuclear utility.** Williams, J.W. Jr. (Florida Power & Light Company, Miami). *Transactions of the American Nuclear Society;* **50**: 488-489(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The Florida Power and Light Company (FP & L) is the fifth largest investor-owned utility in the country. The success of nuclear power generation at the St. Lucie Units 1 and 2 and Turkey Point Units 3 and 4 has resulted from a continuing management commitment to the nuclear program. The management of the power plants rely strongly on teamwork for most large projects and activities whether they entail plant operation, construction, or maintenance. Various examples of how teamwork has been used to realize the successful completion of projects or solutions to problems are given.

2980 Consumption And Utilization

REFER ALSO TO CITATION(S) 38080, 38170, 38206

38134 **Residential energy consumption in low-income and elderly households: how nondiscretionary is it?.** Brown, M.A.; Rollinson, P.A. (Energy Division, Oak Ridge National Laboratory, Oak Ridge, TN). *Energy Systems and Policy;* **9**: No. 3, 271-301(1985).

The energy literature is replete with arguments that the poor and elderly have cut their residential energy consumption to a minimum. This paper challenges these conclusions through an analysis of (data on a sample of Decatur. Illinois homeowners living in single-family, detached dwelling units. The data include utility bill histories and survey information on housing characteristics, energy-related behavior, attitudes, and socioeconomic and demographic characteristics. It shows that residential energy consumption per square foot of living space is significantly higher for the elderly and poor than for the other groups in the Decatur sample. By breaking) energy use into seasonal components, the paper estimates consumption for various household uses. This information, combined with the survey data, suggests that both subgroups have significant discretionary energy use, partly because of the conditions of their homes and partly because of their energy-related behavior. The public policy implications of this finding are discussed.

2990 Unconventional Sources And Power Generation

REFER ALSO TO CITATION(S) 37379, 37709, 37754, 37756, 37772, 37817, 38077, 38078

30 DIRECT ENERGY CONVERSION

3001 Mhd Generators

REFER ALSO TO CITATION(S) 37368, 37369

38135 **(DOE/PC/70507—T1) MHD channel development. Annual topical report, April 1984-September 1984.** (Avco-Everett Research Lab., Everett, MA (USA)). Feb 1985. Contract AC22-84PC70507. 130p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86011633.

MHD generator research and development activities covered by this report are categorized into three broad areas of investigation: MHD Channel Design and Performance; MHD Channel Construction and Lifetime; and MHD Channel Loading and Control. An investigation of the effects of the plasma electrical conductivity near the channel wall on the internal MHD characteristics was completed. Modeling of the diagonal channel with resistive links was completed. A series of LDV experiments was conducted on the Avco Mk VI channel using diagnostics provided by Mississippi State University. Silicon nitride sidewall elements were tested in the Mk VII facility to accumulate operating hours and to test new cooling techniques. Intercathode arcing in a magnetic field was studied, and cathode erosion rates were observed to decrease as arc motion increased. A long-duration test of the Mk VII channel with the objective of sidewall development is in progress. Electrode drops in the Mk VI Reference Channel No. 4 operating without slag were measured, over a range of gas conductivities and magnetic field strengths. A numerical model was built to study the behavior of master/slave consolidation circuits. Results are shown for test cases representing Mk VI Faraday-type consolidation. A set of master/slave current consolidation and control circuitry was tested for 40 hours on the Mk VII channel. The Mk VI and Mk VII test facilities were operated for a total of 103 hours, of which 40 hours were power-generation hours. Improvements were made to the exhaust gas quench system. The supersonic section of the Reference 4 diffuser was reworked to allow simultaneous use of the stagnation pressure probe and the LDV. Shim plates were added to the Mk VI magnet, in order to allow more clearance between the magnet and channel extension sections.

38136 **Multiplex CARS temperature measurements in a coal-fired MHD environment.** (Mississippi State University, Physics Department and MHD Energy Center, Mississippi State, Mississippi 39762-5167). *Applied Optics;* **25**: No. 10, 1684-1692(15 May 1986).

Multiplex coherent anti-Stokes Raman spectra (CARS) of nitrogen were recorded in an environment that simulates the post-magnet gas stream of a coal-fired MHD generator. The presence of coal fly ash and potassium seed created a weakly ionized, highly luminous medium with a high number density of relatively large (1-50-μm) diam particles. Maximum temperatures of 2500 K were mesured with a spatial resoulution of 5 mm. The precision optical alignment necessary for folded BOXCARS phase-matching was maintained for the long distances (>10 m) necessary; to route the laser beams from the CARS instrument to the combustion facility. The increased liminosity caused by injection of postassium seed did not implede the recovery of good quality spectra. The coal fly ash particles precipitated laser-induced breakdown, which, in turn, led to the generation of a coherent interference with N_2 spectra. Techniques to overcome this problem are discussed. A nonlinear least-squares fitting computer program was used to examine systematically the error in inferred temperatures caused by uncertainties in the parameters used in the Kataoka-Teets algorithm employed to reduce the data. The accuracy of the temperature measurements is estimated to be +- 3%.

3005 Fuel Cells

REFER ALSO TO CITATION(S) 37276, 38522, 38522

38137 (DOE/MC/20094—2031) Trace contaminant removal from hot coal gas for molten carbonate fuel cell application. Final report. Patel, P.S. (Energy Research Corp., Danbury, CT (USA)). Apr 1986. Contract AC21-83MC20094. 170p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86001072.

Coal gas fueled molten carbonate fuel cell power plants offer an attractive option for efficient generation of electricity. High temperature removal of coal gas contaminants, such as sulfur, arsenic, halides, tar, etc., is desirable in order to achieve high system efficiency. This experimental study establishes the feasibility of using nickel sorbents for hot trace contaminant removal from coal gas to a sub-ppM level. Chemisorption and desorption characteristics of hydrogen sulfide and arsine on different nickel catalyst were measured between 500 and 700°C. A gas chromatographic method capable of monitoring the contaminant levels down to 20 ppBv in the coal gas was developed and verified.

38138 (LA-UR—86-2044) Potentials for fuel cells in refineries and chlor-alkali plants. Altseimer, J.H.; Roach, F. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 16p. (CONF-860607—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012368.

From 8. annual energy technology conference; Houston, TX, USA (17 Jun 1986).

The market potentials for fuel cell cogeneration systems in petroleum refineries and chlor-alkali plants were evaluated. the most promising application appears to be in chlor-alkali plants where the production process is electricity intensive. Future anticipated changes in the production process are favorable to the use of fuel cells. The energy use in refineries is steam intensive with the required steam pressures ranging from approximately 15 to 650 psig. The near-term use of fuel cell cogeneration in refineries is not as attractive as in chlor-alkali plants. The phosphoric acid fuel cell is the most developed and the most competitive, but its use is limited by its being able to produce only low-pressure steam. Over the longer term, the molten carbonate and the solid oxide fuel cell both of which operate at significantly higher temperatures, are technically very attractive. However, they do not appear to be cost competitive with conventional systems.

38139 (LBL—21184) Structure and activity of Pt-Co alloys as oxygen reduction electrocatalysts. Beard, B.C.; Ross, P.N. Jr. (Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098. 30p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012831.

Carbon supported Pt-Co (3:1 atom ratio) catalysts were prepared in both acid and alkaline aqueous media, followed by heat treatments to promote alloy formation. Both preparations began with a commercial 10% Pt on carbon catalyst with Pt particle sizes of 15 to 30 A. Significantly greater alloying was observed in the acid media prepared catalyst. X-ray diffraction studies of the acid prepared catalyst demonstrated lattice parameters tending away from Pt (3.937 A) and toward that for Pt_3Co (3.831 A), greatly increased particle sizes, and significant ordering evidenced by the presence of superlattice reflections. In all cases, the base media prepared catalysts were alloyed to a lesser extent, were of moderately increased particle size and gave no indication of alloy ordering. Activity testing under phosphoric acid fuel cell conditions demonstrated that the most highly alloyed catalysts had the greatest activity. Loss of cobalt in the phosphoric acid environment was the lowest in catalysts which were the most alloyed.

38140 (PB—86-183597/XAB) Marine applications for fuel-cell technology. Technical memo. (Office of Technology Assessment (U.S. Congress), Washington, DC). Feb 1986. 43p. (OTA-TM-O—37). NTIS, PC A03/MF A01.

OTA found that fuel cells may offer advantages for some marine uses, including applications requiring quiet operations, applications where throttle settings are constantly changed, and for small submarines. However, the marine market is not in itself large enough to drive fuel-cell-technology developments. Fuel cells are not expected to penetrate marine markets until they become firmly established in the commercial utility sector.

38141 (PSI—560/SR-261) Application of fuel cells to chlorine-caustic technology. Taylor, E.J.; Waterhouse, R.; Gelb, A. (Physical Sciences, Inc., Andover, MA (USA)). 1986. Contract FC07-84ID12495. 7p. (CONF-860810—14). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011952.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

A novel system concept for producing concentrated sodium hydroxide at a chlor-alkali plant is described. This system consists of a coupled membrane brine electrolysis cell and membrane alkaline fuel cell reactor. A systems analysis has shown that the Physical Sciences Inc. (PSI) system has the potential for large energy savings for the chlor-alkali industry. The results of screening studies of various advanced cation exchange membranes in this environment are presented and discussed.

3008 Miscellaneous Converters

38142 Machine imparting complex rotary motion for lapping a spherical inner diameter. Carroll, T.A.; Yetter, H.H. (to Dept. of Energy, Washington, DC). US Patent 4,586,292. 6 May 1986. Filed date 30 Jan 1985. vp.

An apparatus is described for imparting complex rotatary motion to at least one subject consisting of: at least one holding means for the subject which rotates the subject around a horizontal axis; at least one means for rotating the holding means around a vertical axis; at least one rotating arm to which the rotating means is attached at a radially outward position, the rotating arm rotating about a vertical axis counter to the rotary motion of the rotating means; a power means to rotate the rotating arm; at least one takeoff means to derive power from power means and induce rotary motion to the rotating means; and at least one secondary takeoff means to derive power from takeoff means and transmit power to the holding means for inducing rotary motion to the subject.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

3201 Buildings

REFER ALSO TO CITATION(S) 37305, 38115, 38116, 38117, 38119, 38120, 38121, 38122, 38123, 38124, 38125, 38793

38143 (BFR-R—119-1985) Significance of the shape factor for indoor climate and energy requirements in a block of flats. Backman, L.; Krantz, P. (Statens Raad foer Byggnadsforskning, Stockholm (Sweden)). 1985. 68p. (In Swedish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752139.

In the course of the outline design for building development in the area near the south station in Stockholm, the shapes and placing of the buildings have been studied with respect to the local climate. The aim of this report has been to supplement these studies regarding the significance of the shape factor for the indoor climate and the pressure/temperature conditions on the outside of the climatic barrier. In this context it has also been necessary to elucidate the collaboration between the building services systems and the building as such. In order that the desired qualities may be achieved and the requirements which are stipulated for reasons other than a low energy consumption may be met, it is important that in the course of the planning and design of buildings account should be taken of the whole sequence ranging from climatic action of the building to the internal climate and the comfort of the inhabitants. The report shows that there is considerable scatter in the results of calculations of the theoretical fabric losses in five different buildings. However, the energy balance in the different buildings is also to a large extent affected by factors which are not taken into account in a theoretical calculation, such as cold bridges in the

facade and the actual airtightness of the building. This is demonstrated in the report.

38144 **(CONF-851202—13) Changes in building heating and cooling requirements due to a reduction in the roof's solar absorptance.** Griggs, E.I.; Courville, G.E. (Tennessee Technological Univ., Cookeville (USA). Dept. of Mechanical Engineering; Oak Ridge National Lab., TN (USA)). 1985. Contract AC05-84OR21400. 43p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012237.

From DOE-ORNL-ASHRAE-BTECC conference on thermal performance of the exterior envelopes of buildings-III; Clearwater Beach, FL, USA (2 Dec 1985).

Sunlit surfaces of buildings experience higher temperatures during hours of solar exposure than those experienced by unexposed surfaces. The solar radiation incident on building exterior surfaces may in turn affect the heating and cooling loads imposed on the building's HVAC system. An increase in surface temperature due to insolation increases heat gain during the summer and reduces heating loss during the winter. Since this is a counteracting influence with regard to energy usage, questions arise as to how annual HVAC energy requirements are changed when a surface's radiative properties are altered. The reported study focused specifically on changes in heating and cooling loads when the roof's solar absorptance was reduced from 0.8 to 0.3. Calculations were made using DOE-2.1B for two different buildings at twenty different cities. A third building type was examined for five of the locations. The paper presents the calculated load changes in the form of bar graphs. The magnitude of the load changes are shown to be significantly influenced by the convective coefficient. For locations of high solar intensity and low heating requirements, use of roofs with low solar absorptance can represent meaningful energy savings.

38145 **(CONF-860818—1) Analysis of lifestyle effects on residential energy use.** Stovall, T.K. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010034.

From American Council for an Energy Efficient Economy Santa Cruz summer study on energy-efficiency in buildings; Santa Cruz, CA, USA (17 Aug 1986).

An analysis of a large data set was performed to identify lifestyle trends or relationships that effect residential energy consumption. The data set was collected by 7 utilities and consisted of about 30 homes in each location. All of these homes had energy consumption data on a 15 minute basis, including submetered space conditioning and water heating energy use. Some of the utilities also measured indoor temperature. Lifestyle information including family size, house size, and house type was collected at some of the utilities. Indoor temperature and heating and air conditioning energy use were examined with respect to outdoor temperature, heating system type, family size, house size, and house type. Hot water energy use was similarly examined.

38146 **(DOE/BP—575) Field performance of refrigerators.** Spolek, G.A. (USDOE Bonneville Power Administration, Portland, OR. Div. of Resource Engineering). Dec 1985. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012268.

For several years, refrigerators have been submitted to laboratory tests in an effort to determine the appliance's typical annual energy consumption and the cost of that energy to the consumer. The standard test procedure, developed by the US Department of Energy, has been criticized for inaccurately reflecting the actual home use of a refrigerator, and thus for producing energy ratings that are unrepresentative. The Bonneville Power Administration (BPA) needs accurate estimates of electric power usage by refrigerators for forecasting and for evaluating the conservation potential of high-efficiency appliances. Prior to embarking on an independent field study, an in-house literature review was conducted which revealed that several field studies of refrigerator performance have been completed. Compilation and analysis of those data indicate that the findings are relatively consistent. On the average, rated refrigerators consume 5% more energy during home use than predicted in laboratory tests. When segregated by design efficiency, the energy consumption of the high efficiency model is very close to the rated value; while conventional design models consume about 10% more than the rating. Overall, refrigerators used in warm climates consume more power than those in cool climates. In the Pacific Northwest, the average refrigerator can be expected to use slightly less electric power than its rating. A more accurate assessment of consumption for refrigerators in the BPA area will be determined by the End-Use Load and Conservation Assessment Program (ELCAP).

38147 **(DOE/BP/17060—1) Heat pump water heater field test.** Hanford, J.; Kennedy, M.; DeLaHunt, M.J.; Palmiter, L. (Ecotope, Inc., Seattle, WA (USA)). Sep 1985. Contract AC79-84BP17060. 126p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86012271.

The purpose of this study was to field test heat pump water heaters (HPWH) to gather information on the performance and potential of the appliance for the Pacific Northwest. The data analysis was performed for Bonneville Power Administration (BPA) by Ecotope, Inc., Seattle, Washington.

38148 **(DOE/BP/18246—1) Conversion standard implementation handbook.** Eley, C. (Eley (Charles) Associates, San Francisco, CA (USA)). May 1985. Contract RP79-84BP18246. 318p. NTIS, PC A14/MF A01; 1; GPO Dep. File Number DE86011939.

The Conversion Standard was issued by the Northwest Power Planning Council (Council) as part of the 1983 "Northwest Conservation and Electric Power Plan" (Plan). State governments, local governments, utilities and Indian tribes are encouraged to adopt the Standard by January 1, 1986. The Conversion Standard applies to both existing residential and non-residential buildings for which the original building permit was granted before January 1, 1986. Buildings receiving an original building permit after January 1, 1986 are required to comply with a more stringent standard for new construction, referred to throughout this document as the New Building Standard.

38149 **(DOE/CE/63428—T1) [Role of small business development in energy conservation]. Final report.** (DAC International, Inc., Washington, DC (USA)). 1986. Contract AC01-85CE63428. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012053.

In anticipation of a projected phase-down in the funding of the Weatherization Program, DOE has been looking for innovative ways to stimulate the local agencies conducting Weatherization programs to continue their weatherization and energy conservation activities without Federal funds or at a reduced funding level. The contract awarded to DAC was to assess, develop and provide the Weatherization Assistance Programs with an action plan for the implementation of a pilot program that would create community-based energy businesses of particular benefit to the low-income population using Federal energy programs as the foundation for the business development.

38150 **(DOE/CE/64855—T1) Alternative financing of energy conservation. Final technical report, September 14, 1984-March 31, 1986.** (New York Energy Office, Albany (USA)). 27 Jun 1986. Contract FG01-84CE64855. 42p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010057.

In September 1984 the New York State Energy Office (NYSEO) received a grant from US DOE to conduct a demonstration program to encourage the use of alternative forms of financing energy conservation projects in the private K-12 school sector. NYSEO sought to test various delivery systems for the provision of financial information and guidance and to encourage the target sector institutions to implement conservation improvements by utilizing the appropriate financing alternatives. Initial focus of the program was on three financing or purchasing options: group purchasing, leasing, and energy performance contracts.

38151 **(DOE/CS/20043—T6) Development and demonstration of a Stirling/Rankine heat activated heat pump. Volume 1. Phase 2. Product development program. Final report.** (General Electric Co., Philadelphia, PA (USA). Advanced Energy Programs Dept.). 25 Apr 1984. Contract AC02-77CS20043;AC05-84OR21400. 677p. NTIS, PC A99/MF A01; 1; GPO Dep. File Number DE86010124.

This report presents the results of the Phase II and Phase IIIB Stirling/Rankine Heat Activated Heat Pump product development program. In the Phase II program, a complete gas fired heat activated prototype residential heat pump system was developed and tested. Results of the product system development are presented in Volume I of this report, emphasizing the key components of the system: the free piston Stirling engine prime mover and the free piston linear inertia compressor.

38152 **(DOE/NBM—6012494) Energy-efficient mobile home: a guide for New Mexicans.** Robertson, D.K.; Cole, R.W. (New Mexico Univ., Albuquerque (USA). New Mexico Research and Development Inst.). [1986]. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012494.

This booklet is primarily for mobile home owners, although many of the energy-saving suggestions will be useful for renters as well. The major part of the booklet deals with energy conservation, followed by a few solar options and remodeling and building addition ideas - things you might consider once you have taken all the fundamental energy conservation steps. A checklist of energy-saving actions, grouped by cost and effectiveness, along with some sources of additional information is included.

38153 **(DOE/R0/00650—T1) Outdoor furnace heats home. [Final report].** LaPage, W. (LaPage (Wilbur), Eagle River, AK (USA)). [1986]. Contract FG06-80R000650. 2p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012895.

The novel project is called a Heating and Heat Storage Apparatus (HAHSA) by the manufacturer. It's a concrete block outdoor furnace that burns wood, trash and coal in a large combustion chamber. Water heated in the furnace is piped back to the house for hot water and baseboard heating.

38154 **(EPRI-EM—3978) Monitoring of improved air-source heat pumps. Final report.** Bullock, C.E.; Hough, R.E.; Pederson, S.C. (Carrier Corp., Syracuse, NY (USA). Research Div.). Jun 1986. 290p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920349.

This report presents the field data and related analysis for seven residential heat pump installations. These results cover both heating and cooling operation for a period of one to two years, depending upon the installation date at each site. This program is a follow-on project from RP789-1, which monitored four residential heat pump installations and one commercial heat pump installation. This report describes the building structures, the associated heat pump systems, and the instrumentation system used to record the performance data. Data summaries are then presented which quantify the actual operating characteristics and performance of these heat pumps in both heating and cooling modes of operation. Analyses of these data are also included to interpret the results, including discussions of electrical demand profiles and utility impacts.

38155 **(EPRI-EM—4659) Analysis of heat pump compressor life. Final report.** Lovvorn, N.C.; Bartolucci, A.A.; Birch, R. (Alabama Power Co., Birmingham (USA)). Jul 1986. 43p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920355.

This report presents results of a study of heat pump compressor service life experienced by heat pump owners in Alabama. Compressor maintenance information was extracted from detailed service records compiled by the Alabama Power Company (APCo) in their Assured Service Heat Pump Program, a 10-year maintenance contract program. The study was performed on nearly 18,000 heat pumps installed over a 20-year period representing seven major manufacturers.

38156 **(EUR—10304-EN) Device for measuring and controlling the energy consumption of heating installations. Summary report.** Gramatte, W. (Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.)). 1985. 43p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energy.

This report describes research and development work which was aimed at the design, construction and prototype testing of a heat meter. The principle of this new heat meter is based on temperature measurements in a heat bridge without moving parts. Extrapolating the results of the various development steps shows that the new device very likely have a longer lifetime (approval period longer than five years), be easier to install, require less maintenance, and be more accurate than other systems commercially available at present. (orig./Hw).

38157 **(LBL—19237) Infiltration degree-days. A statistic for quantifying infiltration-related climate.** Sherman, M.H. (Lawrence Berkeley Lab., CA (USA)). Apr 1986. Contract AC03-76SF00098. 25p. (CONF-8606125—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011556.

From ASHRAE annual meeting; Portland, OR, USA (22 Jun 1986).

A new statistic, Infiltration Degree-Days (IDD), is introduced for quantifying the climatic conditions that influence infiltration. The well-known energy statistic, Degree Days (DD), is used to indicate the severity of climate relative to the conduction load through the building envelope (usually during the heating season). Infiltration Degree-Days (IDD) serves the same function for calculating infiltration and infiltration-related processes that standard degree-days has served for calculating conduction and conduction-related processes. Although standard degree-days is often used to estimate the entire load (i.e., conduction, radiation, and infiltration), it is calculated assuming a linear energy-flow relationship. IDD is designed to overcome the inaccuracies inherent in using standard degree-days for processed like infiltration that are nonlinear (in temperature and other climatic variables); they also potentially solve the problems associated with the use of degree-day formalisms for calculating cooling loads or any situations where the determination of latent heat is a problem. This report presents parallel derivations for standard and infiltration degree-days and includes formulas for determining the base temperature (and enthalpy) methods similar to the many variable-based degree-day methods currently in use for envelope-dominated structures. Also included are tables of heating and cooling IDD for various cases and selected cities in North America.

38158 **(LBL—19337) Seasonal variation in effective leakage area.** Dickinson, J.B.; Feustel, H.E. (Lawrence Berkeley Lab., CA (USA)). Jan 1986. Contract AC03-76SF00098. 28p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012825.

Previous research on the seasonal changes in airtightness has been conducted by other researchers on one or two houses in one location. This paper describes air leakage rate measurements using the fan pressurization technique performed monthly over a period of one year in ten occupied houses in three different climates. The purpose of this study is to determine the seasonal variation in effective leakage area in houses in different climates. The three sets of houses included in this study are located in Reno, Nevada (semi-arid, high desert), Truckee, California (alpine, mountainous), and the San Francisco Bay Area (temperate, coastal). The houses are all wood-frame construction and range from one year to seventy years in age. Indoor and outdoor air temperatures, wind speed, and the moisture content of wood framing and other building components were measured at the time of each fan pressurization test. Indoor moisture levels were monitored by measuring the moisture content of a reference block of wood that was located indoors at each site. The results indicate a seasonal variation in effective leakage area in some but not all of the houses; the largest variations are seen in the Truckee houses with effective leakage areas up to 45% higher in the summer as compared to those measured in midwinter.

38159 (LBL—19752) Virginia Electric and Power Company. Financial impacts on utilities of load shape changes project: stage III summary report. Eto, J.H.; McMahon, J.; Chan, P. (Lawrence Berkeley Lab., CA (USA)). Dec 1984. Contract AC03-76SF00098. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012759.

Efficiency standards for residential appliances can affect the earnings of electric utilities. The magnitude and direction of the effect depends on the retail rate and marginal cost structure of the individual utility. The goal of this LBL project is to develop tools and procedures to measure this effect for a range of different utilities. We use two end-use models in sequence to estimate the load shape changes induced by residential appliance standards, and a modified formulation of the accountant's statistic for earnings before interest and taxes (EBIT) to calculate the financial impact.

38160 (LBL—20288) Parametric analysis of thermal mass in residential buildings. Byrne, S.J.; Ritschard, R.L. (Lawrence Berkeley Lab., CA (USA)). Dec 1985. Contract AC03-76SF00098. 24p. (CONF-851202—12). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012011.

From DOE-ORNL-ASHRAE-BTECC conference on thermal performance of the exterior envelopes of buildings-III; Clearwater Beach, FL, USA (2 Dec 1985).

This paper summarizes an analysis of the impact of various wall and building design characteristics on the energy savings due to thermal mass in exterior walls of residential buildings. Thermal mass effects on annual heating and cooling loads were examined in 12 climates for three types of exterior walls - insulation either inside or outside of the mass layer and with insulation and mass well mixed. Using a parametric series of computer simulations and multiple regression analysis, the results were reduced to simple equations that predict the performance of massive walls in typical residences. These regression equations are suitable for use in microcomputer energy analysis programs and other simplified design and analysis tools. Although the use of thermal mass can be an effective means of reducing both heating and cooling loads, the magnitude of the savings is shown to depend on a complex interaction of parameters including the climate, the amount and physical properties of the mass, the location and amount of insulation in the exterior walls and building design parameters that affect either solar gain or natural ventilation rate.

38161 (LBL—21318) Residential standards demonstration program: cost analysis. Vine, E. (Lawrence Berkeley Lab., CA (USA)). May 1986. Contract AC03-76SF00098. 226p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE86012830.

The Pacific Northwest is currently experiencing a dramatic and exciting transformation in the way the region produces and consumes energy. Prompted by federal legislation and local initiative, the region is promoting the conservation of energy as the primary energy resource. In the residential sector, energy efficiency standards (Model Conservation Standards, MCS) for new construction have been proposed, and a demonstration program (the Residential Standards Demonstration Program, RSDP) is underway to demonstrate to the homebuilding industry what the MCS are, how to comply with them, and increase the industry's familiarity with them. Another objective of the RSDP is to document the cost-effectiveness of the MCS by collecting energy use and cost data on the homes participating in the program. This report examines the costs associated with building energy efficient homes using real data compiled by builders and their sub-contractors (energy data will be presented at a later time).

38162 (NP—6752106) Veneer wall on the existing houses. Falk, C.P.; Knutsson, H.H.; Moeldrup, E.; Prebensen, K. (Cowiconsult Raadgivende Ingenioerer A/S, Virum (Denmark)). Sep 1984. 167p. (In Danish). NTIS (US Sales Only), PC A08/MF A01. File Number DE86752106.

A detailed survey of the building's facade should be carried out to ensure that the detailing of the veneer wall will be based upon the actual conditions. It is especially important that dimensions of basement stairs, window wells, openings, piers, balconies, sills, cornices etc. are established. The footings for the veneer wall will normally be executed in conjunction with the existing foundations, either by widening the existing foundations or by their being hung up upon them. The report deals primarily with veneer walls of clay bricks. It is, however, possible to use other types of brick, eg. calcium silicate bricks. The geometry of the veneer wall should be based upon a total survey of the existing building. The report describes two in principle differing methods of execution, i.e.: - the staggered execution, and - the parallel execution. The staggered method of execution is to be recommended as it implies fewer possibilities of faulty execution. The width of the cavity has great influence upon the behaviour of the veneer wall and the wall ties under the influences of own load, wind load and temperature changes. Thermal and moisture movements of the veneer wall must be freely possible in order that detrimental cracking of the brickwork does not occur. The report includes an outline of control classes, material and structural control, safety classes etc. DS 414's rules and regulations for control are commented upon.

38163 (ORNL/CON—172) Linear harmonic analysis of free-piston Stirling engines. Chen, N.C.J.; Griffin, F.P. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 104p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86012451.

The equations that govern the behavior of free-piston Stirling engines are nonlinear differential equations. Traditional solution methods have been time-stepping integrations that can be plagued by numerical instabilities and can use large amounts of computer time. Closed-form analytical solutions are possible if the working gas behaves isothermally or if the nonlinear terms in the governing equations are replaced with accurate approximations. An almost closed-form solution method, called the linear harmonic analysis (LHA), has been developed for free-piston Stirling engine applications by representing all of the periodic variables with harmonic functions. The solution method accounts for the important thermodynamic losses that are coupled together in free-piston engines, yet it is efficient enough for optimization studies. The LHA method was compared with a standard numerical integration method to verify its mathematical accuracy. The LHA and numerical predictions for a sample free-piston Stirling engine configuration differed by $<5\%$ for all important parameters. Sensitivity studies using the LHA method have also shown that the thermodynamic loss assumptions used in an analysis can have a significant impact on the predicted dynamic behavior of a free-piston Stirling engine.

38164 (ORNL/Sub—79-42539/6) Heat transfer characteristics of walls with similar thermal resistance values. Final report. Larson, S.C.; Van Geem, M.G. (Construction Technology Labs., Skokie, IL (USA)). Jun 1986. Contract AC05-84OR21400. 151p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86012452.

Heat transfer characteristics of building elements must be known to evaluate energy losses through a building envelope. Laboratory tests of walls for dynamic outdoor temperture conditions provide data that can be used to determine thermal properties. Dynamic testing is particularly important for massive envelope components that store as well as transmit heat. A normal weight concrete wall with board insulation on the outdoor surface was tested in the calibrated hot box facility at the Construction Technology Laboratories, a division of the Portland Cement Association. The wall consisted of 8 in. (200 mm) of normal weight concrete with 5/8-in. (16-mm) polyisocyanurate board insulation bonded to the outdoor surface.

38165 (ORNL/Sub—79-42539/7) Surface temperature measurement techniques for a calibrated hot box test specimen. Final report. Larson, S.C.; Van Geem, M.G. (Construction Technology Labs., Skokie, IL (USA)). Jun 1986. Contract AC05-84OR21400. 85p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012450.

Heat flow through a 143 pcf (2290 kg/m^3) normal weight concrete wall was measured using the calibrated hot box facility at the Construction Technology Laboratories, a division of the Portland Cement Association. Two methods of measuring specimen surface temperatures were used to investigate thermal contact resistance between thermocouples and a normal weight concrete specimen. Thermocouples used to measure surface temperatures fre-

quently are taped to the wall surfaces. In this test program, thermocouples were also embedded in wall surfaces. The wall was subjected to steady-state, transient, and periodically varying temperature conditions. Steady-state results are used to determine concrete thermal conductivity and wall resistance. Data obtained during transient and periodic temperature variations are used to define dynamic thermal response of the wall.

38166 **(ORNL/Sub—80-7985/1) Monitoring of residential groundwater-source heat pumps in the northeast. Final report.** Dougall, R.S.; Freedman, G.M.; Osborne, R.W.; Mohre, D.L. (Pittsburgh Univ., PA (USA); Allegheny Electric Cooperative, Inc., Harrisburg, PA (USA)). Mar 1986. Contract AC05-84OR21400. 80p. NTIS, PC A05/MF A01; GPO Dep. File Number DE86012456.

Two rural Pennsylvania single-family residences in a 6000 heating degree-day climate, were retrofitted with add-on groundwater-source heat pumps. Performance data were collected over a two-year period. Data were collected manually and by microcomputer, and included weather, energy use of the heat pump and house, water flow and temperature. Compared to oil, at 1984 prices, a payback of 4 to 6 years is possible. One unit operated at a COP in heating of nearly 3.0, including an allowance for pumping energy. The COP of the second unit was lower, still better than oil heating but not cost-effective at today's rates. Some initial reliability problems were also encountered with one unit. This emphasizes the need for astute buying and use of comparative ratings on models at conditions consistent with the application. As water-source heat pump performance is affected by water supply temperatures, the rating must be for temperatures similar to groundwater temperatures in the region where the heat pump will be installed, typically 50 to 55°F in Pennsylvania. A substantial quantity of water is required and proper disposal is a consideration. Ponds were used to receive processed water in both test applications. The source groundwater was obtained from wells of more than 50 feet in depth, which are common at rural residences.

38167 **(PB—86-183514/XAB) Energy efficiency in buildings: behavioral issues. Final report.** Stern, P.C. (National Research Council, Washington, DC (USA)). 1985. 122p. NTIS, PC A06/MF A01.

The report deals with consumer choice and energy use in buildings. Previous reports of the committee have explored how knowledge from the behavioral and social sciences (in addition to economics) could illuminate energy policy issues; using the same approach, the report addresses four topics: (1) consumer adoption of energy-efficient retrofits of existing buildings, (2) consumer response to financial incentive programs for residential energy conservation, (3) the design of energy-efficiency rating systems for homes, and (4) the problems of explaining differences between predicted and achieved energy savings from home retrofits. The report provides a framework for identifying behavioral issues regarding energy efficiency in buildings and for choosing methods to analyze them.

38168 **(PB—86-189891/XAB) Building energy analysis with BLAST and CEL-1.** Treado, S.J.; Holland, D.B.; Remmert, W.E.; Pierpoint, W. (National Bureau of Standards, Washington, DC (USA). Center for Building Technology). Feb 1986. 174p. (NBSIR—85/3256). NTIS, PC A08/MF A01.

The report describes the capabilities of the BLAST and CEL-1 computer programs and the procedures for using a hybrid version that incorporates both programs into a single design and analysis tool. Details on assembling the required information for development of the input files, and the actual execution of the hybrid program are covered. The program allows detailed simulation of actual lighting systems using CEL-1 including daylighting effects while providing BLAST with lighting energy modifiers on an hourly basis. The procedure is demonstrated using a sample building.

38169 **(PB—86-189909/XAB) HVACSIM+ building systems and equipment simulation program: building-loads calculation.** Park, C.; Clark, D.R.; Kelly, G.E. (National Bureau of Standards, Washington, DC (USA). Building Equipment Div.). Feb 1986. 203p. (NBSIR—86/3331). NTIS, PC A10/MF A01.

A nonproprietary building-system simulation program called HVACSIM+, which stands for HVAC SIMulation PLUS other systems, was developed at the National Bureau of Standards (NBS) in an effort to understand the dynamic interactions between a building shell, an HVAC system, and building controls. HVACSIM+ consists of a main simulation program, a library of HVAC system component models, a building shell model, and interactive front end input-data-generation programs. The report presents the overall architecture of the HVACSIM+ program, algorithms used in the main simulation program, a brief discussion of the numerical methods used in solving a system of nonlinear simultaneous equations, integrating stiff ordinary differential equations and interpolating data and descriptions of the building shell and zone models.

38170 **(PB—86-189925/XAB) United states commercial building population and energy consumption: an overview. Topical report, November 1985-March 1986.** Bluestein, J.; Bernstein, H. (Applied Management Sciences, Inc., Silver Spring, MD (USA)). Apr 1986. 191p. (C—154). NTIS, PC A09/MF A01.

The report provides an overview and analysis of the characteristics of the U.S. commercial building population in order to productively target gas-technology R & D.

38171 **(PNL-SA—13041) Energy redesign of the Hirshhorn Museum and Sculpture Garden.** Crawley, D.B.; Wong, L.S.; Cantrell, J.M. (Pacific Northwest Labs., Richland, WA (USA); Jones, Nall and Davis, Inc., Atlanta, GA (USA)). Jul 1985. Contract AC06-76RL01830. 7p. (CONF-8503101—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012324.

From Research and design '85; Los Angeles, CA, USA (14 Mar 1985).

A study of energy consumption patterns, energy conservation opportunities, and economic return in the Hirshhorn Museum and Sculpture Garden (HMSG) was conducted in 1982 for the Smithsonian Institution, Office of Design and Construction. This study was but one part of the Smithsonian's program to improve energy efficiency in all their buildings. In the study, existing conditions and operation patterns were determined, opportunities for energy conservation were identified, energy conservation measures were analyzed for energy and economic return, and implementation recommendations were made. Potential savings of 57.2% in energy consumption and 63.4% in annual energy costs were identified, yielding a Savings-to-Investment Ratio (SIR) of 6.9 and a simple payback period of 2 years. This paper describes the study, along with its conclusions and recommendations.

38172 **(PNL-SA—13739) Overview of the software-based federal residential conservation standard.** Lee, A. (Pacific Northwest Labs., Richland, WA (USA)). Jan 1986. Contract AC06-76RL01830. 28p. (CONF-8606125—5). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012325.

From ASHRAE annual meeting; Portland, OR, USA (22 Jun 1986).

Federal statute requires the Department of Energy to develop and issue energy conservation performance standards for residential buildings. The standard for federal construction has been completed and is unique because of its software-based format. User federal agencies will implement the standard by inputting necessary location, building type, equipment type, and conservation option information and the software will produce a point system compliance form. The software contains embedded cost and energy data used to derive the most cost-effective combination of conservation options. The point system compliance form presents potential builders with energy consumption information needed to determine design compliance or to perform tradeoffs between alternative design options. This software provides an alternative to complex graphs,

tables, and calculations that would be needed to determine compliance and tradeoffs with the cost-effective performance standard.

38173 **(PNL-SA—13904) Project on restaurant energy performance end-use monitoring and analysis.** Mazzucchi, R.P. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 38p. (CONF-8606125—4). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012328.

From ASHRAE annual meeting; Portland, OR, USA (22 Jun 1986).

This paper summarizes the results of a research program intended to build an understanding of restaurant energy performance upon an empirical foundation. This discussion provides some background for this effort, brief descriptions of the facilities selected for study, the measurement methods, the empirical findings, an overview of conservation opportunities revealed, and general conclusions. Seven monitoring sites were carefully selected to represent the most common categories of food service by the National Restaurant Association. A microcomputer based data acquisition was designed and implemented to acquire 15-minute interval data on end-use energy consumption, interior temperatures, and external climate conditions for a one year monitoring period. The project archived over 87% of the available data, which has been converted into several formats for dissemination. Restaurants are found to be very intensive users of energy due largely to the frequent usage of food preparation equipment and the high ventilation requirements.

38174 **(PNL-SA—13941) Early results from commercial ELCAP buildings: schedules as a primary determinant of load shapes in the commercial sector.** Reiter, P.D. (Pacific Northwest Labs., Richland, WA (USA)). Mar 1986. Contract AC06-76RL01830. 24p. (CONF-8606125—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012327.

From ASHRAE annual meeting; Portland, OR, USA (22 Jun 1986).

This paper examines the importance of scheduling in the determination of total energy use and the temporal distribution of end use consumption. Four archetypes of diurnal end use load shapes are proposed. These archetypes are used to describe the interaction between schedules and lighting, equipment, heating and cooling loads in the determination of end use load shapes. The concepts of schedule and temperature-determined end use loads are then empirically examined using two buildings from the ELCAP metering project. Hourly end uses are examined and compared to the archetypes. The primary conclusions of the work are that schedules appear to play a dominant role in determining the diurnal and seasonal shape of loads for the commercial sector as a whole. Case studies on individual buildings, including the two described in the paper, appear to confirm these observations concerning the commercial sector load shape.

38175 **(SBI-R—162) Upgrading of buildings combined with post-insulation work.** Noerregaard, M.; Nicolajsen, A. (Statens Byggeforskningsinstitut, Hoersholm (Denmark)). 1985. 39p. (In Danish). Statens Byggeforskningsinstitut, P.O. Box 119, DK-2970 Hoersholm, Denmark. Price: Dkr. 63,75.

EFP-80.

In this report is shown how energy saving measures regarding the building envelope often may be combined with renovation work, which should have been done in any case for one reason or the other. The different parts of the building envelope are analyzed and possible measures are described. In order to demonstrate the idea a pilot project has been carried out. Here a number of windows in a 14 years old block of flats have been furnished with exterior aluminium frames with one layer of glass. In this way the wooden windows have been protected and energy savings have been obtained by increasing the number of window panes from two to three. In the report it has been calculated that the pay-back period in this case will be approximately seven years.

38176 **(SBI-R—167) Renovation of radiator systems. A report of a balancing project.** Christiansen, J. (Statens Byggeforskningsinstitut, Hoersholm (Denmark)). 1985. 72p. (In Danish). Statens Byggeforskningsinstitut, P.O. Box 119, DK-2970 Hoersholm, Denmark. Price: Dkr. 106,75.

EFP-81.

The present report gives an account of a project dealing with various degrees of renovation of three radiater systems in one and the same housing area. The project has shown that renovation of a heating plant can be carried out in a systematic way, but that it is necessary to submit the radiator system to thorough calculations. Often a number of components has to be replaced. It is essential that the necessary baslancing valves are there. The renovation resulted first of all in an improvement of the thermal comfort: rooms which previouly had been cold, now had a normal room temperature. This improvement, however, may have been on of the reasons why the energy savings turned out to be smaller than expected. The oil measurements during a four month's period before and after the renovation, respectively, showed that the radiator system with the most comprehensive renovation - including the mounting of thermostatic radiator valves - achieved energy savings of approximately 9 percent. At the other two radiator systems, where only the risers were balanced, the savings were about 3 percent.

38177 **(SBI-R—176) Laboratory testing of joints around wooden window frames. Effect of the external use of mastics on moisture content of the frame wood.** Lohse, U. (Statens Byggeforskningsinstitut, Hoersholm (Denmark)). 1986. 26p. (In Danish). Statens Byggeforskningsinstitut, P.O. Box 119, DK-2970 Hoersholm, Denmark. Price: Dkr. 61.

EFP-82.

This report deals with laboratory measurements of moisture content in window frames placed in solid masonry with a one-stage joint executed either as a traditional mortar joint or a mastic joint in the exterior part of the joint between the window and the wall. By placing the windows between a warm and a cold room the windows have been exposed to a moisture gradient simulating Danish winter conditions. The aim was to study if condensation took place behind mastic joints with a high diffusion resistance and if any water caused by condensation would be absorbed by the wooden frame as this would create a risk for rot and decay in the window frames. Rain penetration in the joint has been simulated by injecting water into the joint in order to study how the following drying out took place. The window surfaces towards the exterior were painted with either and acrylic paint (low diffusion resistance) or an oil paint (high diffusion resistance) in order to see if this difference had an effect on the moisture content of the frame. The laboratory experiments have not shown any signs of moisture problems due to water vapour diffusion regardless of the type of joint used. The drying effect did not seem to be affected by the type of paint. The conclusion is that it has not in connection with the laboratory experiments been possible to detect any detrimental effects caused by the mastics used as one-stage joints in solid (old) masonry walls.

38178 **(SjF-Beretning—19) Energy consumption in pigsties.** Moeller, F. (Statens Jordbrugstekniske Forsoeg, Horsens (Denmark)). Sep 1984. 30p. (In Danish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752104.

The examinations have been carried out under practical conditions and have comprised registration of the energy consumption in piggeries for ventilation, heating, feed preparation, feeding and handling of manure. Concerning the measuring technique. it was easy to register the energy consumption for the various branches of the pig production, whereas it is more difficult to explain the results because the variations from one house to another were very big. There are many variations, but concerning the ventilation plants, it is mainly a question of air flow per animal, of desired indoor temperature, of insulation, and especially the age of the ventilation plant, because the output of air per kWh of the plants has increased considerably during recent years. Concerning the heating, a big consumption is in most cases caused by a poor regulation of heating and ventilation. As basis is used the average respectively the minimum and the maximum energy consumption per animal place per year registered in the examination, as well as a pig production unit of 100 sows producing 2000 piglets and bacon pigs per year.

38179 (SjF-Beretning—24) Heat pumps in animal shelters. Petersen, S.; Takai, H.; Johansen, P. (Statens Jordbrugstekniske Forsoeg, Horsens (Denmark)). Feb 1985. 41p. (In Danish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752103.

The first heat pumps for animal houses, which appeared on the market in the mid-seventies, were nearly all of the type air-water with evaporators made of copper-aluminium. These heat pumps caused great problems with corroded evaporators, which often result on breakdown of compressors. The average working time for these evaporators was only 2 years. Investigations on heat pumps for animal houses, carried out by SjF in 1979-1984, showed that the dependability has been improved considerably. Today most heat pumps for animal houses are of the type liquid-water with heat collectors made of synthetic materials, and interruptions of operations on the heat collecting side are now very seldom. Since 1979 measurings have been carried out on 34 heat pumps for animal houses, and the power factor has been calculated on the basis of input and output energy. To obtain a better understanding of heat pump dimensioning a number of measurings of heat collectors' ability to gather heat from the animal houses have been carried out. It showed that the efficiency of heat collector with a good approximation is proportional with the difference of temperature between the animal house and the heat collector. Due to this, the stable temperature must be as high as possible within the limits that are given by the production. The investigation also showed, that the heat collecting efficiency increases with increase of flow of the liquid in the heat collector. The amount of air passing through the heat collector has also influence, but it is less significant.

38180 (STF—15A85038) HVAC control process simulation. Boerresen, B.A. (SINTEF, Trondheim (Norway)). Jul 1985. 64p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86752126.

The modeling and simulation of heating, ventilation and air conditioning (HVAC) systems and their controls is necessary for properly understanding the dynamic performance of heating and cooling processes in buildings. This is of great importance both for design and development of new control concepts. A simplified simulation methodology is presented which can take into account the important non-linearities. The approach can easily be implemented on micro computers. The influence of length of time step in simulation and simplifications reguarding time constants are discussed. Finally an example of air quality control analysis is describes (in Norwegian). An air exchange model for the room and a ventilation on/off controller is simulated.

38181 (SVF—190) Control methods for the insulation of district heating pipe joints. Rundstroem, T. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Apr 1985. 51p. (In Swedish). (STUDSVIK-EI—84-118). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752145.

Control methods for detecting cavities in polyurethane foam insulation, i.e. for district heating pipe joints, have been investigated by means. of experiments and theoretical calculations. The investigations concern measurements of surface temperatures and some unconventional methods including x-ray radiography, neutron radiography, acoustic and electric methods. Of the investgated methods, thermography and x-ray photography are recommended. When using an IR-camera for thermography, the minimum difference of approximately 55 degrees C between the service pipe temperature and the ambient temperature is needed to be able to detect cavities of interest. The accuracy of the measurements will be reduced if the polyethylene casing of the joint is exposed to solar radiation, wind or rainfall. Cavities larger than approximately 10 mm in the direction of exposure will be detected by x-ray radiography. 2-3 exposures will be needed for each joint controlled at a cost of 200 - 300 SEK. A proposal for requirements on maximum permitted cavity dimensions is submitted in the report. The requirements are adjusted to accuracy of the thermography and x-ray methods. This investigation has been financed by the Thermal Engineering Research Association in Sweden. 8 refs.

38182 (VTT-TIED—527) Renovation of oil heating systems up to 1995. Lehtinen, E.; Pajakkala, P.; Nykaenen, V. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). 1986. 31p. (In Finnish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752489.

The study deals with the renovation of buildings in Finland during the early eighties, and prospects for future development. It shows the proportion that heating, ventilation and electrical equipment play in renovation. A particular focus and attention is paid on the need to renew oil-fired boilers, oil burners and oil storage tanks in individual buildings by the year 1995. In this report, the term renewal refers to equipment that has become of age when it should be replaced or thoroughly renovated. What is more, the report gives a broad outline of the effects of these renovations on the energy consumption of buildings. The proportion of renovation work in regard to house building is conspiciously increasing. It is expected that renovation work will continue to increase by up to 5 per cent a year. The amount of money spent on the construction of buildings is, however, only slightly increasing compared with recent years. This increase is mainly concentrated on renovation work. The development of the restoration of heating, ventilation and electrical equipment is in line with the development of restoration work in general.

38183 (VTT-TIED—538) Influence of airtightness on air infiltration. Luoma, M. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). 1986. 63p. (In Finnish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752307.

The purpose of this study was to obtain detailed information on the airtightness of the test house of the Technical Research Centre of Finland. The information is needed in other studies made in the house and to the physical reliability of the calculation model for airtightness and air infiltration developed in the Laboratory of Heating and Ventilating. The airtightness of the building envelope was measured by pressure test and local airtightness measurements. The local airtightness of doors and windows was measured by collector chamber method. The structural joints were divided into four types for which the leakage characteristics were determined. The total air leakage of the structural joints was adjusted to the results of the whole house pressure test. The physical reliability of the model was tested by comparing the results of calculations with the measured fresh air flows to rooms and pressure differences between indoor air and outdoor air. When the ventilation rate was 0.5 air changes per hour the measured and calculated results agreed quite well.

38184 (VTT-TUTK—385) Use of concrete hollow core slabs as a part of the heating and ventilation systems. Siro, H.; Kantojaervi, K. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). 1985. 76p. (In Finnish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752493.

Concrete hollow core floor slabs in a row house are used as heat storage by conducting the heated air into the flat through the hollow cores placed crosswise in the slabs. In addition to warm-air heating, the flat is also provided with a radiator heating system and a storing fire-place. Each of the heating systems can be used separately or together with others, so a comparison between several alternative heating systems has been possible. A right location and shape chosen for the house helped in an attempt to utilize passive solar energy. The room air warmed by the sun or by means of the fire-place was circulated through the hollow core slabs in the daytime and the energy stored at the time in the concrete was thus discharged by circulated air. By changing the heating methods different periods of heating are examined. Measurements were made of weather conditions, indoor temperatures and of temperatures of concrete floor slabs, of energy consumption and of the distribution of energy currents to different objects of use. Main emphasis was focused on the charge and discharge of the hollow core slabs. Our goal is a heating system, in which the warm water storage heated by night electricity, can be replaced to some extent or even entirely with building mass used as a storage. At night there is more electricity otainable and thus its use also cheaper.

38185 (ESA-TT—12) Mass and heat transfer in reflux condensers for absorption heat pumps. Mack, R. (European Space Agency, 75 - Paris (France)). Aug 1985. Translated from Stoff- u. Waermeuebertragung bei Ruecklaufkuehlern fuer Absorptionswaermepumpen, DFVLR-FB—84-43, Hardthausen am Kocker, West Germany, (Jul 1984). (DFVLR-FB—84-43). 43p. NTIS, PC A03/MF A01; original German version available from DFVLR, Cologne DM 15.50.

An equation to calculate horizontal reflux condensers was deduced. It makes mass and heat transfer computable depending on known numerical values of the process variables. The equation is demonstrated by experiments with two absorption heat pumps working with ammonia water solution. Parameter studies are made with a computer program to show the different dependences and to guarantee an efficient construction. The program is extended to allow the computation of other than nominal conditions. Computation and test results show good agreement.

38186 Efficiency improvement concepts for residential gas-fired furnaces and water heaters. Talbert, S.G.; Putnam, A.A.; DeWerth, D.W.;. (Battelle Columbus Labs., Columbus, OH). *ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Transactions;* **86**: 327-345(1980).

To evaluate energy-saving modifications and design approaches for residential gas-fired appliances, AGA and Battelle examined 63 concepts in nine areas: combustion, combustion air, venting, heating exchange, ignition, controls, heat-delivery system, field modifications, and improved equipment. The study evaluated each concept in terms of its estimated steady-state efficiency, seasonal efficiency, range of expected installed cost, operating power, standby power, calculated range of payback period, and gas, electricity, and cash savings. Many of the concepts exhibited the potential of saving substantial amounts of gas within a reasonable (4-year) payback period. Some are already appearing on the market in new appliances or as retrofit devices, and many more will soon become economically worthwhile to market if fuel prices keep rising. Because several concepts for improve appliance performance employ a condensing heat exchange, the study recommended condensing systems as a prime subject for further R and D.

3202 Transportation

38187 (DOE/NASA/50112—62-Rev.) Stirling Powered Van Program overview. Revision. Shaltens, R.K. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. Contract AI01-85CE50112. 12p. (NASA-TM—87227-Rev.; CONF-860263—1-Rev.). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011386.

From Society of Automotive Engineers international congress and exposition; Detroit, MI, USA (24 Feb 1986).

The Stirling Powered Van Program (SPVP) is a multiyear, multiphase program to evaluate the automotive Stirling engine (ASE) in Air Force vans under realistic conditions. The objective of the SPVP is to have a manufacturer and end user(s) (i.e., on the path to commercializatin) of the second-generation Mod II ASE upon completion of the Automotive Stirling Engine Program in 1987. In order to meet this objective, the SPVP must establish Stirling performance, integrity, reliability, durability, and maintainability. This paper reviews the ASE Program background leading to the Van Program and focuses on plans for evaluating the kinematic Stirling engine in Air Force vans. Also discussed are the NASA technology transfers to industry that have been accomplished and those which are currently being developed.

38188 (EPRI-EM—4636) Energy consumption in the transportation services sector. Final report. Rappoport, P.N.; Rodenrys, K.J.; Savitt, J.H. (Wharton (E.F.A.), Inc., Philadelphia, PA (USA)). Jun 1986. 108p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920359.

The econometric model developed in this study allows analysts to forecast long-term trends in the use of various forms of energy for transportation. Incorporation, as it does, both supply and demand decisions, utilities may also find the methodology helpful in assessing trends in electric transportation.

38189 (NP—6752472) Pipeline transport - an energy saving form of transportation. (Cowiconsult Raadgivende Ingenioerer A/S, Virum (Denmark)). Apr 1986. 65p. (In Danish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752472.

EFP-85.

38190 (ORNL/TM—9897) Driver energy conservation awareness training. Review and recommendations for a national program. Greene, D.L. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 84p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012453.

The idea of driver energy conservation awareness was formalized as a training program (DECAT) by the Department of Energy in the late 1970's. This report reviews the curriculum of that program, its basis in engineering tests and principles, its past activities and achievements, and its potential, and makes recommendations for a renewed program. There is ample evidence that typical drivers can reduce fuel consumption by at least 10% by the way they maintain and operate their vehicles. The original DOE program was reasonably successful in reaching motor vehicle fleets, especially in government. Challenges for a new DECAT program include increasing its outreach to the general motoring public, fostering research and transfer to the marketplace of effective driver feedback devices, and incorporating DECAT training into the driver education and licensing process, nationwide. Depending on the effectiveness of DECAT, motor fuel savings could range up to 10 billion gallons annual.

38191 Route profile analysis system and method. Mullenhoff, D.J.; Wilson, S.W. (to Dept. of Energy, Washington, DC). US Patent 4,586,138. 29 Apr 1986. Filed date 29 Jul 1982. vp.

A vehicle data acquisition system is described which consists of: distance measuring means for measuring the distance traveled by a vehicle per unit time; means for periodically sensing the inclination of the longitudinal axis of the vehicle relative to the horizontal plane; micro-processor means for digitally recording the measured distance and the sensed inclination, the recorded measured distance and sensed inclination to be used to determine the profile of a route traveled by the vehicle with the distance measuring means and the inclination sensing means providing sufficient data to determine true inclination of the vehicle over all portions of the route.

3203 Industry And Agriculture

REFER ALSO TO CITATION(S) 37308, 37710, 37754, 38548, 38663

38192 (DOE/CE/30784—H3) Modular systems for energy recovery from municipal waste. (Science Applications International Corp., Falls Church, VA (USA)). Jun 1986. Contract AC01-83CE30784. 52p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86012087.

This report presents the findings of an assessment of the research and development (R and D) activities and needs of the industry manufacturing modular combustion systems for the recovery of energy from municipal solid waste (MSW). It also includes a review of the current status of the industry and all municipal waste units installed to date.

38193 (EGG-M—10186) Comparative economic evaluation of industrial heat pumps. Bliem, C.J.; Mills, J.I. (Idaho National Engineering Lab., Idaho Falls (USA)). 1986. Contract AC07-76ID01570. 7p. (CONF-860810—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011037.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

This paper presents the findings of a study on the cost of delivering process heat with state-of-the-art heat pump systems. Sixteen heat pump systems were configured for relative cost compari-

sons. These systems consisted of electrically driven, prime energy driven, and waste energy driven reverse Rankine cycle heat pumps of the open, semiopen and closed type. In addition, a waste energy driven absorption heat pump was analyzed. A conceptual design of each system was created using off-the-shelf components generally available to engineering firms. The performance of each system was assessed, the major components sized, and the installed cost determined. Maintenance costs were estimated. Finally, the relative cost of energy delivered by each system was estimated, and the cost of delivery heat with state-of-the-art heat pumps was determined.

38194 **(ERATL—86/16/XAB) Improving the selection and efficient use of electric-motor drive systems.** Knights, D.E. (ERA Technology Ltd., Leatherhead (UK)). Jan 1980. 451p. (ERA—79-0123). NTIS, PC A$205.00/MF $205.00.

The report advises users and manufactures of existing electric-motor drive systems on how to minimize the summation of first cost and energy costs by improving the selection and specification of such equipment for their particular drive requirements. Most types of drive component are considered, including ac and dc motors, variable speed controllers, etc. The four main application areas, pumps, fans, air compressors and machine tools, are discussed in some detail, and topics such as power-factor correction and electrical demand control are also included.

38195 **(EUR—10144-EN) Production of hot gas for drying processes using fluidised bed combustion of coal. Final report.** Payne, R.C.; Windybank, A.R.; Butt, A.R.; Smith, T.N.; Margrett, P.J. (Commission of the European Communities, Luxembourg. Directorate General Information Market and Innovation). 1985. 155p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energy.

A twin cell fluidised bed furnance has been operated in a gasifier/char combustor mode to determine optimum conditions and geometric configurations for production of high temperature exhaust gas. A sucessful design has been developed and during steady state conditions gas compositions have been analysed and final mixed gas temperatures in excess of 1250°C have been achieved. Satisfactory scale-up would enable coal fired furnances to directly replace oil and gas for dryers and mineral processing requiring these high temperatures. Such coal furnances would be smaller, and hence cheaper, for a given output, than their lower temperature predecessors and would offer significant fuel cost savings over oil and gas firing. (orig.).

38196 **(NP—6752108) Electronic regulated hot plate.** Holck, J.; Nygaard, I. (Danmarks Tekniske Hoejskole, Lyngby. Fysisk Lab. 3). Oct 1985. 99p. (In Danish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752108.

Investigations have shown that an accurate control of the temperature of an electric hot plate can reduce the energy consumption by approx. 20%. In the present work, two different principles of control are developed and tested. The first is based on a direct identification of the heat capacity and the temperature of the contents of the pot. This principle, implemented as the program DCON, has previously been examined, and it is here further developed as the program RACON, adding yet a measurement of temperature and a more detailed model description. RACON has been tested at a demonstration setup by preparing typical dishes, e.g. cooking rice and potatoes as outlined in test-specificiations. The second principle, based on prediction of the temperatures by means of a time series model, has previously been giving promising results, when controlling a simulated system. It has, however, not been possible when using measured data to make predictions with the expected accuracy. Thus, tests have only been performed with the prediction part of the control-principle, and not with the control part. Considering the results obtained, it is not expected possible to implement a controller, based on this principle, that is sufficiently accurate to fulfill the given test-specifications, covering all kinds of cooking. On the other hand it seems possible, for both principles, to develop a controller, that in a satisfactory way can be used for boiling water, perhaps including potatoes and the like. The interest in such a controller is expected to be significantly smaller than in a general controller.

38197 **(NRL-R—59) Fly ash in cementbound sand for roadbase. Accelerated testing in road testing machine.** Busch, C. (National Road Lab., Roskilde (Denmark)). Jan 1986. 35p. National Road Laboratory, P.O. Box 235, DK-4000 Roskilde, Denmark. Price: Dkr 100.

Full scale testing of a reference pavement and a test pavement was carried out in the Danish Road Testing Machine to compare the lifetime of the pavements. The reference pavement was a traditional structure consisting of asphalt, gravel base and sand subbase. The test pavement had a base of fly ash/cement/lime stabilized sand. The pavements were built on a typical Danish clay subgrade. Traffic loading was simulated by dual wheel passages under varying climatic conditions including freeze/thaw periods. The pavements were instrumented with strain gauges, linear varible differential transformers and pressure cells of the diaphragm type. Functional deterioration was determined by calculation of a serviceability index from measurements of roughness, whereas structural deterioration was established by measurements with the Falling Weight Deflectometer. Comparison was made between measured and calculated strains and stresses, as well as between observed functional and structural design lives and predictions based on Danish design criteria. In the first freeze/thaw period the stabilized sand base-course cracked. During the tests there was no indication of cracking in the asphalt layer.

38198 **(ORNL/Sub—85-22014/1) New industrial chemical heat pump working fluids. Final report.** Rockenfeller, U.; Horn, G. (Nevada Univ., Boulder City (USA). Energy and Environmental Engineering Center). May 1986. Contract AC05-84OR21400. 147p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86012482.

Liquid-vapor sorption pairs can be used as working fluids in heat pumps of the temperature amplifier (TA) type as well as the heat amplifier (HA) type. This report describes the theoretical and experimental investigation of new sorption pairs applicable to industrial heat pumps in the temperature range 80°C to 250°C. The candidate fluids were divided into two groups: inorganic aqueous solutions, and organic fluids using TFE as the refrigerant. Both groups were investigated in theory and experiment. The fluid pair TFE-E181 was superior to any binary or ternary aqueous solution for the TA concept. The lift characteristics of the organic pair can reduce the requirement of two-stage hardware configurations to the less expensive single-stage concepts in many applications.

38199 **(SVF—189) Transport of waste heat or primary heat over long distances - supplemented by simple surveying of waste heat sources.** Jacobsson, B. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Apr 1985. 55p. (In Swedish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752144.

The cost of the installation for some ordinary types of culverts which are used by the Swedish industry and heating plants is presented. The cost is divided into expenses of material projecting, construction and restoration. A model has been worked out to calculating the total cost of the transport of hot water from the waste heat source to users. The economic length of distribution pipes is estimated. Possible industrial heat sources have been surveyed.

38200 **(SVF—196) Degassing of feedwater at thermal equilibrium.** Dahlen, G.; Jacobsson, B.; Aakesson, H. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Aug 1985. 60p. (In Swedish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752151.

There is an increased interest in recovery of condensate in order to save energy. This may result in negative effects when temperatures and flows are increased and degassing problems will arise and efficiency can be reduced. The prevalent physical conditions on degassing are discussed and calculated for a real case at pulp and paper industry. It is shown that certain alterations at the economizer and its feedwater flow will increase the efficiency and render pay-off time of 2 to 5 years. It is advisable to cool the condensate by heat exchange with the incoming air to the boiler. The pay-off time will be only a couple of months. Constructional improvements and method recommendations are presented.

38201 (TKK-KO/ET—8) Report of the energy consumption in industrial drying operations. Kaermeniemi-Putkiranta, M.; Kontro, J. (Helsinki Univ. of Technology, Otaniemi (Finland). Inst. of Energy Engineering). Oct 1985. 81p. (In Finnish). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752109.

This report deals with industrial drying operations and the heat recovery systems in drying. The present energy use efficiency and the operation parameters in drying are also discussed. This study is based on the literature on drying concerning the values of specific energy consumption and the heat recovery systems in drying. The main parameters affecting the energy consumption in drying are the dryer type, the inelt air temperature, the temperature drop of the air in the dryer and the water content of the wet material being dryed. Heat losses occur by heat transmission through the walls of the dryer and within the outlet air. The heat recovery systems are based on recycling, the use of heat exchangers and heat pumps. Air-to-air heat exchangers such as heat pipes, twin coils, recuperative shell and tube heat exchangers and regenerative heat wheels are commonly used. Heat pumps are less common because of their low condensing temperature. Heat pumps are mainly used in timber drying, where the drying temperature is rather low. Drying with superheated steam is energy effective, but the price of the device is so high that the system is only in prototype use so far. In the end of this study drying is handled as part of the whole water removing system. The water removing operations compared are filtering, centrifuging, pressing, evaporating and membrane technology. All of these are less energy intensive than thermal drying. The investment costs and the running expenses were calculated for the water removing operations of some typical materials and common device types. Special attention was paid to energy costs.

38202 (TKK-S/ST—48) Optimization of load and fuel allocation at a multi-fuel boiler plant. Lautala, P.; Vallisuo, H. (Helsinki Univ. of Technology, Otaniemi (Finland). Control Engineering Lab.). Aug 1983. 26p. (In Finnish). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752120.

Wood products industry is one of the most important energy producers and consumers in Finland. Own fuels (bark, peat, black liquor) as well as imported fuels (coal, oil natural gas) are used in power generation. Steam consumption of a plant may vary considerably and therefore in one system there can be coupled together several different boilers. Because of several fuels and boilers it has been a problem to reach an optimal operational situation of boilers and corresponding load of the system. Optimization of load and fuel allocation at multi-fuel boiler house is dealt with. A pair of two-level algorithm for solving the problem is presented. The allocation algorithms calculate for every future steam production level the most economical load and fuel schedules. An example with four boilers and three possible fuels is presented.

38203 (VTT-TIED—243) Energy research of the mechanical wood processing industry in 1980-1982. Handbook of timber drying. Siimes, H. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). 1983. 150p. (In Finnish). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752490.

The drying costs constitute a remarkable part of the production costs of timber. The knowledge of the cost structure and those facts, that effect the structure, are necessary when trying to minimize the production costs. The book consists of basic information, which help the user himself to cope with the drying costs and minimize them. The drying-process consumate 3/4 of the heat energy used in the sawmills and 1/3 of the electric power, and that is why the air processing, the calculation of the energy consumption in the drying unit and also the possible energy conservation methods are discussed on a large scale.

38204 (VTT-TIED—498) Biotechnical methods for saving energy in the pulp and paper industry. Kantelinen, A.; Mustranta, A.; Perttula, M.; Poutanen, K.; Viikari, L. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). Oct 1985. 70p. (In Finnish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752300.

The most important present applications of biotechnology in the pulp and paper industry are biological treatment of waste waters and utilization of spent sulphite liquors for single cell protein or ethanol production. Anaerobic fermentation of waste waters offers economic advantages as compared with aerobic treatment: methane is produced, the requirement for electrical energy is low and sludge formation is minimized. The energy consumption of the active sludge process can also be decreased by applying modern control technology. However, the amount of energy needed in the waste water treatment is only a few percent of the energy consumption of the whole mill. Many potential biotechnical applications are being studied intensively. The biological degradation of lignin probably has considerable potential in saving energy in the forest industry. Biological treatment could possibly be combined with mechanical or chemical delignification. Bio-delignification processes may also include treatment of roundwood or chips, bleaching and treatment of waste waters. There is growing interest in the application of plant tissue culture methods and in the genetic engineering of cells from tree lines. The productivity of forest plantations may ultimately be increased substantially with the aid of these technologies.

38205 (VTT-TUTK—384) Exploitation of the heat of dry kiln exhaust air. Siimes, H. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)). 1986. 75p. (In Finnish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752308.

The main part of the heat brought into a drying kiln escapes through ventilation. The only way generally used for the exploitation of the heat contents of the exhaust air is its use for preheating of the entering air in a heat exchanger. This way, however, only a minor portion of the theoretical energy of the exhaust air can be used. The aim of the study was to search for other cost effective means of exploiting the exhaust air. Energy consumption was calculated for a progressive kiln when drying different sizes if Scotch pine lumber with different drying schedules in different outdoor temperatures using heat exchangers of different efficiency. The enthalpy and magnitude of exhaust air were also calculated. A new kind of kiln working at two different temperature levels was sketched, and several trials were carried out to find out suitable drying schedules for the new kiln.

3206 Municipalities And Community Systems

REFER ALSO TO CITATION(S) 37374, 37817, 37831, 38066, 38083, 38539

38206 (KTM/E-B—54) Impact of different power consumer groups on the total power supply cost. Tarjanne, R.; Rouhiainen, P.; Poikela, E. (Ministry of Trade and Industry, Helsinki (Finland). Energy Dept.). 1985. 69p. (In Finnish). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752491.

This report made by order of the Ministry of Trade and Industry deals with the impact of different power consumer groups on the total power supply cost taking into account the varying consumption pattern of consumer groups and the technical, economical and availability chracteristics of different power plants. In addition, the report compares the revenues of the distribution tariffs based on the tariffs of the bulk sale electricity pricing system H/85 with the calculation results by means of the power purchase of typical consumers. The costs have been allocated to the different consumer groups using three causing principles. The impact of the uncertainty factors in the basic data on the reliability of the basic calculation results has been studied by sensitivity analysis which only shows that the calculation discount rate has a considerable effect on the calculation results. For tariff comparisons, typical consumers have been defined whose power purchace has been calculated by using the sample tariffs taken from the fulk sale tariff H/85 of Imatra Power Company (IVO = Imatran Voima Oy) and the new distribution tariff recommendation of the Finnish Association of Electricity Supply Undertakings (SLY) based on the former. Because of the valuation method of the existing power supply system, the prices of electricity calculated through the causing principles can be compared with the prices calculated through the tariffs only as relative values. The prices to be compared have been proportioned to the mean price weighted by the consumption shares of all consumer groups. The price relations of the sample tariffs were found

to follow rather well the price relations calculated through the causing principles.

38207 (LBL—19751) Pacific Gas and Electric Company. Financial impacts on utilities of load shape changes project. Stage II technical report. Eto, J.H.; McMahon, J.; Chan, P. (Lawrence Berkeley Lab., CA (USA)). Jun 1984. Contract AC03-76SF00098. 48p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012681.

The goal of this LBL project is to develop tools and procedures that measure the financial impacts of load shape changes to utility stockholders. In this application, the financial impacts of exogenous policies that raise the efficiencies of residential appliances are studied. The analysis is based on detailed forecasts of energy use by computer simulation models developed at LBL. These models disaggregate both annual energy use and hourly system electric loads at the end-use level. This detail is essential for calculating production and capacity cost benefits, and tariff-class specific revenue changes. Several analytical procedures commonly employed by the industry independent of one another are combined into an integrated assessment of the impacts of load shape changes on utility shareholders.

38208 (PB—86-183571/XAB) Resource recovery from municipal solid waste. Bulletin. Stanczyk, M.H.; DeCesare, R.S. (Bureau of Mines, Tuscaloosa, AL (USA). Tuscaloosa Research Center). 1985. 37p. (BM-B—683). NTIS, PC A03/MF A01.

As part of its mission to investigate and encourage recovery and recycling technologies, the Bureau of Mines studied the feasibility of recovering metal and nonmetallic mineral values from municipal solid waste. The bulletin reviews Bureau research conducted primarily between 1966 and 1979, which covered various aspects of recycling municipal solid waste and included operation of both a municipal incinerator residue and a raw (unburned) refuse continuous-separation pilot plant. The report describes the products recovered from incinerated and raw refuse and research in upgrading, refining, and/or utilizing the various metal and mineral products.

3209 Education And Public Relations

REFER ALSO TO CITATION(S) 38084

33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

38209 (N—86-21578) Bibliography of electrothermal thruster technology, 1984. Sovey, J.S.; Hardy, T.L.; Englehart, M. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Mar 1986. 49p. (NASA-TM—86998; E—2536). NTIS, PC A03/MF A01.

Electrothermal propulsion concepts are briefly discussed as an introduction to a bibliography and author index. Nearly 700 citations are given for resistojets, thermal arcjets, pulsed electrothermal thrusters, microwave heated devices, solar thermal thrusters, and laser thermal thrusters.

3301 Internal Combustion Engines

REFER ALSO TO CITATION(S) 37377, 37378

38210 (AD-A—165655/2/XAB) Structure of high-speed sprays. Final report. Bracco, F.V. (Princeton Univ., NJ (USA). Dept. of Mechanical and Aerospace Engineering). Feb 1985. 119p. NTIS, PC A06/MF A01.

The conclusions are that: the breakup of full-cone diesel jets is due primarily to aerodynamic interaction between the liquid surface and the chamber gas; the initial average size and velocity of the drops formed by the breakup of the outer surface of the jet can now be estimated and so can the length of the intact core but with greater uncertainty; after breakup a steady full-cone spray undergoes a development similar to that of incompressible jets; in diesel engines it is the development region that is important; the major parameter in the difference between full-cone sprays and incompressible jets is the liquid-to-gas density ratio; in the absence of vaporization the most advanced of the available spray model reproduce full-cone sprays with adequate realism for applications; it is not yet known how vaporization changes the structure of these sprays and if available models adequately reproduce the changes.

38211 (DOE/CE—0027/4) Automotive Technology Development Program. Seventh annual report to Congress. (Department of the Air Force, Los Angeles, CA (USA); USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC. Office of Transportation Systems). Dec 1985. Contract AI01-82CS50286. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010883.

DOE's Automotive Technology Development Program formulated in response to the Act consists of three major engine-related projects: (1) the Automotive Gas Turbine Engine Development Project, (2) the Automotive Stirling Engine Development Project, and (3) the Heavy Duty Transport Technology Project. In addition, basic ceramic materials technology for all engine projects is being developed under the Advanced Materials Development Project.

38212 (LBL—20878) Compression ignition of coal slurry fuels. Brehob, D.D.; Sawyer, R.F. (Lawrence Berkeley Lab., CA (USA)). Dec 1985. Contract AC03-76SF00098. 31p. (CONF-860804—10). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86007496.

From 21. international symposium on combustion; Munich, F.R. Germany (3 Aug 1986).

Slow- and medium-speed compression ignition engines have the potential for conversion to coal fueling. Previous engine studies on coal slurries have investigated wear, thermal efficiency, and injection performance without evaluating the ignition characteristics. The ignition delay times and conditions for ignition of 45 mass % coal in methanol, diesel No. 2, and water are compared to diesel No. 2 and methanol in the present study. The slurries are evaluated using a 900 rpm, direct injection, square piston engine simulator operating for one combustion cycle per experiment. Both 16:1 and 22:1 compression ratios are used with 2 atm abs. inlet air at temperatures from ambient to 250°C. The square geometry accommodates windows on two opposite walls of the combustion chamber for complete optical access. All of the test fuels except coal/water slurry ignited at the operating conditions attainable in the engine simulator. The temperature at time of injection required to obtain ignition is approximately 680 K for diesel No. 2 and coal/diesel slurry, 725 K for coal/methanol slurry, and 825 K for neat methanol. Activation temperatures, T/sub á/, in the Arrhenius-type expression are: 5559 K for diesel No. 2, 7685 K for methanol, 3541 K for coal/diesel, and 5330 K for coal/methanol by the pressure delay method and 4357 K for diesel No. 2, 3926 K for coal/diesel, and 5510 K for coal/methanol by the luminosity delay method. The results establish the compression ignitability of the coal/methanol and coal/diesel slurry fuels at conditions appropriate to medium-speed diesel engines.

38213 The effect of engine speed on the TDC flowfield in a motored reciprocating engine. Bopp, S.; Vafidis, C.; Whitelaw, J.H. Warrendale, PA; Society of Automotive Engineers, Inc. (1986). 10p. (CONF-860263—). Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

From Society of Automotive Engineers international congress and exposition; Detroit, MI, USA (24 Feb 1986).

Measurements of three velocity components have been obtained by forward-scatter laser Doppler anemometry in the transparent cylinder of a modified production engine motored in the speed range 300-2000 rpm with a disc-type combustion chamber and a compression ratio of 7.4. The in-cylinder flow development has been examined in detail with and without induction swirl at an engine speed of 1000 rpm. In both cases turbulence was non-isotropic during compression with a tendency towards isotropy at TDC. The swirl velocities at TDC of compression scaled linearly with engine speed while the volume-averaged turbulence intensity varied more than linearly with engine speed for both induction

system configurations, increasing from 0.45 to 0.6 times the mean piston speed in the absence of induction swirl and from 0.4 to 0.5 with induction swirl.

38214 **Vehicle evaporative and exhaust emissions as influenced by benzene content of gasoline.** Seizinger, D.E.; Marshall, W.F.; Cox, F.W.; Boyd, M.W. Warrendale, PA; Society of Automotive Engineers, Inc. (1986). 28p. (CONF-860263—). Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

From Society of Automotive Engineers international congress and exposition; Detroit, MI, USA (24 Feb 1986).

Five late model vehicles equipped with representative emission control systems were used to determine the effect of benzene concentration of gasolines on evaporative and exhaust benzene emissions. The vehicle selection included three different fuel induction systems and two different exhaust emissions control systems. The test fuels consisted of 25 and 40% aromatic base fuels each at four benzene levels ranging from 0.02 to 4%. Evaporative and exhaust determinations included measurement of regulated emission components and benzene emission in each test segment. Benzene level in the fuel tank head space was also measured. In addition to the above evaporative and exhaust emission test program, exhaust samples were collected simultaneously before and after the exhaust emissions control system to determine engine-out and tailpipe-out emission rates as well as the catalyst conversion efficiency.

38215 **Cycle-resolved velocity and turbulence measurements in an IC engine with combustion.** Hall, M.J.; Bracco, F.V.; Santavicca, D.A. Warrendale, PA; Society of Automotive Engineers, Inc. (1986). 12p. (CONF-860263—). Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

From Society of Automotive Engineers international congress and exposition; Detroit, MI, USA (24 Feb 1986).

Laser Doppler velocimetry has been used to make cycle-resolved velocity and turbulence measurements in a homogeneous-charge, spark-ignition engine. The engine had a ported intake and disc-shaped chamber with a compression ratio of 8 to 1. It was operated at a speed of 1200 rpm and with a TDC swirl number of 4. A stoichiometric propane-air mixture was used, and ignition was near the wall. The velocity measurements were made at three spatial locations at the midpoint of the clearance height. Tests were made to determine whether the presence of the flame affected the accuracy of the velocity measurements. It was found that the ensemble-averaged mean velocity shows a small deviation, and the rms fluctuation intensity is significantly influenced, but the effects appear to be confined to the flame zone. Data rates were sufficiently high in the preflame and postflame regions to determine the velocity history in each cycle (cycle resolved). The cycle resolved turbulence intensity was found to increase across the flame. The turbulence intensity in the burned gas was found to be homogeneous at the three spatial locations examined and to decay rapidly. There was little or no increase in turbulence intensity ahead of the flame.

38216 **Semiempirical analysis of fuel-air ratio distribution downstream of a plain orifice injector under nonuniform crossflow.** Chin, J.S.; Li, W.M.; Cao, M.H. (Purdue Univ., West Lafayette, IN; Beijing Institute of Aeronautics and Astronautics, People's Republic of China). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

The Cao, et. al., (1982) semiempirical analysis of liquid fuel distribution downstream of a plain orifice injector has been improved through the incorporation of experimental data for plain orifice atomization under cross flow, and consideration of the effect of nonuniform cross flow. The model is thereby rendered capable of predicting the maximum value of the fuel-air ratio distribution and its position; the results obtained for the position of maximum fuel-air ratio changing with the averaged velocity for the same profile are in good agreement with experimental data. These results are pertinent to combustor design development. 7 references.

38217 **Heat transfer in internal combustion engines.** Wang, C.S.; Berry, G.F. New York, NY; American Society of Mechanical Engineers (1985). 7p. (CONF-851125—).

From American Society of Mechanical Engineers winter annual meeting; Miami, FL, USA (17 Nov 1985).

A heat transfer model has been developed that uses quasi-steady heat flux relations to calculate the heat transfer from combustion gases through the cylinder wall to the coolant in an internal combustion engine. The treatment of convective heat transfer accounts for the physical problems of rotating and impinging axial flow inside the engine cylinder. The radiative heat transfer includes gas radiation (CO_2, H_2O, and CO) and soot-particle radiation. Cylinder wall temperatures can be accurately predicted from this model for both the gas and coolant sides. The present model's heat transfer results for the motoring case are in good agreement with results from empirical correlations based on instantaneous heat flux data. The calculated radiative heat flux and gas emissivity show reasonable agreement with data in the literature.

38218 **Fluid motion during flame propagation in a spark ignition engine.** Witze, P.O.; Martin, J.K.; Borgnakke, C. (Sandia National Labs., Livermore, CA). *Society of Automotive Engineers Technical Paper Series;* **840377**: 1-14(1984).

From Society of Automotive Engineers international congress and exposition; Detroit, MI, USA (27 Feb-2 Mar 1984).

Laser Doppler velocimeter results are presented for the mean velocity and turbulence intensity measured during combustion in a research engine. Simultaneously with each LDV measurement, the cylinder pressure and gas state (unburned or burned) were measures so that conditional sampling techniques could be used in the data-averaging procedure. Measurements of the mean velocity component in the direction of flame propagation agree well with a computer simulation of the induced velocities generated by the volume expansion of the burned gases. Mean velocities measured parallel to the flame surface are shown to be complex because a small amount of swirl was present. Conditional sampling on the time of flame arrival at the LDV probe volume revealed a thirty percent cyclic-variation bias error in the turbulence component normal to the flame. The turbulence field ahead of the flame appears to be enhanced by compression, with the component normal to the flame increased twice as much as the parallel component. 28 references, 16 references.

38219 **Optical measurements of hydrocarbons emitted from a simulated crevice volume in an engine.** Medina, S.C.; Green, R.M.; Smith, J.R. (San Jose State Univ., CA). *Society of Automotive Engineers Technical Paper Series;* **840378**: 1-10(1984).

From Society of Automotive Engineers international congress and exposition; Detroit, MI, USA (27 Feb-2 Mar 1984).

The process of hydrocarbon emission from an engine crevice was simulated in an operating research engine by the introduction of a small tube into the combustion chamber. This simulated crevice volume was used to determine the fate of unburned hydrocarbons that interact with the crevice. Shadowgraph photography and spontaneous Raman spectroscopy were used to determine flow patterns, temperatures, and hydrocarbon concentrations 1 mm from the tube opening. Hydrocarbon species were first detected at the tube exit late in the expansion stroke, long after the start of outflow from the simulation volume. A flame was never observed near the tube exit. Unburned hydrocarbons exiting the tube did not undergo rapid oxidation at temperatures up to 1400 Kelvins. 21 references, 11 figures.

38220 **Multidimensional modeling of auto-ignition in spark-ignition engines.** Natarajan, B.; Bracco, F.V. (Princeton Univ., NJ). *Combustion and Flame;* **57**: 179-197(1984). Contract AC04-81AL16338.

Proposed mechanisms and models for engine knock are reviewed and the so-called Shell global model for the low-temperature ignition chemistry of hydrocarbon/air mixtures is selected. The model is first applied to spatially uniform charges in a constant volume bomb and in a rapid compression machine. The trends computed are found to compare favorably with experiments. Next, cool flames in isooctane/air and n-heptane/air mixtures in a stirred reactor are computed and compared with experiments. Trends match

closely but magnitudes do not. Finally the charge in a spark-ignition engine is considered and a fully coupled two-dimensional model (with a finite-thickness flame) is used to study engine knock. It is found that the structure of the finite-thickness flame determines whether it is accelerated by the preflame reactions or is not affected by them. The two limits are studied and the trends computed in the latter one are found to be in better agreement with the majority of the experiments. It is also found that, while single stage ignition is sufficient to model strongly knocking cycles, it is inadequate for those of marginal knock, which are the more important ones in practice, in which cool flames precede and, in fact, delay the onset of knock. 29 references, 13 figures, 5 tables.

38221 **Heat transfer as a determent of end-gas knock.** Carrier, G.; Fendell, F.; Fink, S.; Feldman, P. (TRW Space and Technology Group, Redondo Beach, CA). *Combustion Science and Technology;* 38: 1-48(1984). Contract AC04-78ET13329.

A three-zone model of the nonisobric combustion event in a variable-volume enclosure is developed. The three zones are: the burned gas, the unburned charge in the normally cooled region, and the unburned charge in the region with augmented cooling. The heat transfer in these zones is distinguished by locally applicable polytropic relations, which prove to be tractable means of parametrically introducing heat transfer into this highly simplified unsteady one-dimensional model. The results indicate that augmented heat transfer from the end gas can prevent those temperatures for which autoconversion is likely to arise in the residual charge. At moderate engine speed (~2000 rpm), if ignition and final burn-up occur roughly symmetrically with respect to piston-crown displacement from top dead center, for the prevention of knock, the fraction of the combustible mass that must be regarded as end gas (and subjected to enhanced cooling by heat transfer) is approximately one-half. 16 references, 18 figures, 4 tables.

38222 **Diesel exhaust opacity: at the port and a meter downstream.** Ferguson, C.R.; Chapman, M.; Kizawa, H.; Nash, R.F. (Purdue Univ., West Lafayette, IN). *Society of Automotive Engineers Technical Paper Series;* 831724: 1-11(1983).

From Fuels and lubricants meeting; San Francisco, CA, USA (31 Oct 1983).

Instantaneous opacity measurements have been made for gases in the exhaust port and one meter downstream. The results obtained showed the opacity to be time independent with negligible variation from cycle to cycle except near the smoke limit, and an order of magnitude greater at the port than one meter downstream. Results are compared with gas sampling measurements of the particulates. 22 references, 12 figures, 5 tables.

38223 **Measurements and predictions of the precombustion fluid motion and combustion rates in a spark ignition engine.** Witze, P.O.; Martin, J.K.; Borgnakke, C. (Sandia National Labs., Livermore, CA). *Society of Automotive Engineers Technical Paper Series;* 831697: 1-11(1983).

From Fuels and lubricants meeting; San Francisco, CA, USA (31 Oct-3 Nov 1983).

Laser Doppler velocimeter results are presented for the mean velocity and turbulence intensity measured in a motored research engine. The compression of complex bulk motions created during induction produces turbulence as the piston approaches top dead center. The turbulence field is shown to be isotropic but nonhomogeneous. A zero-dimensional computer simulation based on an averaged k-ϵ model is shown to adequately predict the decay of turbulence at a point in the flow after the production phase is completed. Cylinder pressure measurements were recorded for homogeneous stoichiometric combustion for a range of engine speeds and ignition locations. A two-zone (burned and unburned gases) thermodynamic model accurately predicts the measured pressure histories when the turbulence results determined from the motored tests are used to establish initial conditions for the combustion model. 18 references, 12 figures.

3307 Emission Control

REFER ALSO TO CITATION(S) 38214, 38219, 38222

38224 **(PB—86-183779/XAB) Environmental assessment of a reciprocating engine retrofitted with selective catalytic reduction. Volume 1. Technical results. Final report, March-December 1984.** Castaldini, C.; Waterland, L.R. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Apr 1986. 71p. NTIS, PC A04/MF A01.

This report gives results of comprehensive emission measurements and 15-day continuous emission monitoring for a 1500-kW (2000-hp) gas-fired, four-stroke turbocharged reciprocating engine equipped with an ammonia-based selective catalytic reduction system for NOx control.

38225 **(PB—86-183787/XAB) Environmental assessment of a reciprocating engine retrofitted with selective catalytic reduction. Volume 2. Data supplement. Final report, March-December 1984.** Castaldini, C.; Waterland, L.R. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Apr 1986. 72p. NTIS, PC A04/MF A01.

This report gives results of comprehensive emission measurements and 15-day continuous emission monitoring for a 1500-kW (2000-hp) gas-fired, four-stroke turbocharged reciprocating engine equipped with an ammonia-based selective catalytic reduction system for NOx control.

3308 Alternative Fuels

REFER ALSO TO CITATION(S) 37377, 37378, 37503, 38212, 38215

36 MATERIALS

38226 **(CONF-860829—23) Localized ion milling of metallic and ceramic TEM specimens.** Fisher, A.T.; Bentley, J. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 3p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86009538.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

The utility of localized ion milling in the preparation of metallic and ceramic specimens for TEM and AEM is being evaluated from the standpoint of optimizing procedures and identifying limitations and milling characteristics. The equipment used was a Gatan model 645 precision ion milling system (PIMS). This device is a scanning ion beam instrument with which selected areas of a sample can be imaged by either secondary electron or secondary ion signals and selectively ion milled in a small region within the imaged area. The 1 to 10 keV ion beam can be focussed to a 2 μm spot. Specimens are thinned without removing them from the electron microscope specimen holder.

3601 Metals And Alloys

REFER ALSO TO CITATION(S) 37265, 37716, 37859, 37859, 37894, 37903, 37936, 37936, 37937, 37946, 37946, 37981, 37994, 37995, 37995, 37996, 37997, 38003, 38437, 38522, 38628, 38705, 38904, 39247, 39418, 39418, 39424, 39428

38227 **(BNL—38043) Functional pendent groups affecting chemisorption and adherent properties of polyelectrolyte-zinc phosphate composite conversion coatings.** Sugama, T.; Kukacka, L.E.; Carciello, N. (Brookhaven National Lab., Upton, NY (USA)). Apr 1986. Contract AC02-76CH00016. 6p. (CONF-8604209—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011537.

From ADPA corrosion prevention and control conference; Williamsburg, VA, USA (28 Apr 1986).

The ability of polyelectrolyte macromolecules to suppress the crystal growth of zinc phosphate (Zn.Ph) conversion coatings depends primarily on the species of the functional pendent groups. The extent of chemisorption of carboxylic and sulfonic acid groups

on the crystal faces was considerably higher than that for amide groups. The internal diffusion of polyelectrolyte on the Zn.Ph crystal acted significantly to improve the mechanical properties and alkaline resistance of the crystal coatings. The reaction products formed by chemical interactions between the urethane groups in the polyurethane topcoat and the carboxylic acid groups in the Zn.Ph composite precoat played an essential role in developing the interfacial adhesive forces.

38228 **(CONF-851217—67) Measurement of equilibrium and nonequilibrium segregation by x-ray microanalysis.** Kenik, E.A. (Oak Ridge National Lab., TN (USA)). 1985. Contract AC05-84OR21400. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012239.

From Materials Research Society meeting; Boston, MA, USA (2 Dec 1985).

X-ray microanalysis in an analytical electron microscope is a proven technique for the measurement of solute segregation in alloys. Solute segregation under equilibrium or nonequilibrium conditions can strongly influence material performance. X-ray microanalysis in an analytical electron microscope provides an alternative technique to measure grain boundary segregation, as well as segregation to other defects not accessible to Auger analysis. The utility of the technique is demonstrated by measurements of equilibrium segregation to boundaries in an antimony containing stainless steel, including the variation of segregation with boundary character and by measurements of nonequilibrium segregation to boundaries and dislocations in an ion-irradiated stainless steel.

38229 **(CONF-860421—55) Effects of solutes on damage production and recovery in zirconium.** Zee, R.H.; Birtcher, R.C.; MacEwen, S.R.; Abromeit, C. (Argonne National Lab., IL (USA); Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.; Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.)). Apr 1986. Contract W-31-109-ENG-38. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012131.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Dilute zirconium-based alloys and pure zirconium were irradiated at 10 K with spallation neutrons at IPNS. Four types of alloys - Zr-Ti, Zr-Sn, Zr-Dy and Zr-Au - each with three concentration levels, were used. Low-temperature resistivity damage rates are enhanced by the presence of any of the four solutes. The greatest enhancement was produced by Au while the least by Dy. Within each alloy group, damage production also increased but at a decreasing rate, with increasing concentration. Post-irradiation annealing experiments, up to 400 K, showed that all four solutes suppress recovery due to interstitial migration, indicative of interstitial trapping by the solutes. Vacancy recovery is also suppressed by the presence of Sn, Dy or Au. The effect of Ti is to shift this stage to lower temperature. No clear correlation between the results with solute size was detected.

38230 **(CONF-860805—1) Thermal simulation of quenching uranium-0.75% titanium alloy in water.** Siman-Tov, M.; Llewellyn, G.H.; Childs, K.W.; Ludtka, G.M.; Aramayo, G.A. (Oak Ridge National Lab., TN (USA)). 1985. Contract AC05-84OR21400. 24p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86001356.

From International heat transfer conference; San Francisco, CA, USA (17 Aug 1986).

A computer model, The Quench Simulator, has been developed to simulate and predict in detail the behavior of U-0.75 Ti alloy when quenched at high temperature (about 850°C) in cold water. The code allows one to determine the time- and space-dependent distributions of temperature, residual stress, distortion, and microstructure that evolve during the quenching process. The nonlinear temperature- and microstructure-dependent properties, as well as the cooling rate-dependent heats of transformation, are incorporated into the model. The complex boiling heat transfer with its various regimes and other thermal boundary conditions are simulated. Experiments have been performed and incorporated into the model. Both sudden submersion and gradual controlled immersion can be applied. A parametric and sensitivity study has been performed demonstrating the importance of the thermal boundary conditions applied for achieving certain product characteristics. The thermal aspects of the model and its applications are discussed and demonstrated.

38231 **(CONF-860829—4) APFIM study of antiphase and grain boundaries in Ni_3Al.** Horton, J.A.; Miller, M.K. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 5p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86008494.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Ni_3Al is an ordered intermetallic material and is potentially useful for high temperature applications. Unlike most alloys the yield stress of Ni_3Al actually increases with an increase in temperature. Unfortunately, pure Ni_3Al exhibits a brittle intergranular fracture and, consequently, low ductility. However, doping Ni_3Al with boron improves the mechanical properties and can result in room temperature ductilities up to 50% and a completely transgranular failure. Auger electron spectroscopy (AES) has shown that boron segregates to those boundaries which can be made to fail intergranularly and that no embrittling agents are found on fracture surfaces of pure Ni_3Al. Atom probe field-ion microscopy (APFIM) is an excellent technique to study the structure and chemistry of "good" boundaries, especially for light elements such as boron. Results from this study have shown that boron segregates to both grain boundries and antiphase boundaries (APB) and that a thin phase is usually present at the grain boundaries in rapidly solidified Ni_3Al.

38232 **(CONF-860829—6) Use of analytical electron microscopy in evaluating ferrite stability in austenitic stainless steel welds.** Vitek, J.M.; David, S.A. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86008537.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Stainless steel weld filler metals are prone to hot-cracking during welding. If the primary mode of solidification is ferrite formation rather than austenite formation, the tendency for hot-cracking is reduced. Type 308 stainless steel is such a filler metal which solidifies as primary ferrite and is relatively immune to hot-cracking problems. During further cooling, the primary ferrite transforms to austenite. When such duplex austenite plus ferrite weld microstructures are subjected to elevated temperature applications, the residual ferrite is unstable and transforms. Analytical electron microscopy has been used to study the ferrite stability. Results have provided insight into the stability of ferrite during welding and also during service at elevated temperatures. This paper considers three cases in which the use of analytical electron microscopy has led to understanding of ferrite stability in duplex type 308 stainless steel welds.

38233 **(CONF-860829—9) Characterization of spinodally-decomposed Fe-30.1% Cr-9.9% Co. Part 1.** Horton, L.L.; Miller, M.K.; Spooner, S. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 2p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86008340.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Transmission Electron Microscopy (TEM), Atom Probe Field-Ion Microscopy (APFIM) and Small Angle Neutron Scattering (SANS) have been used to characterize the microstructure of a commercial Fe-30.1 at. % Cr-9.9 at. % Co alloy. One goal of this investigation was to demonstrate the complementary nature of these techniques in solving a difficult materials problem, the characterization of fine scale spinodally-decomposed structures. The alloy was solution treated at 925°C for 140 min followed by water quenching, isothermal aging at 525°C for times of 2, 8, 24, 72, 192, or 485 h and a final water quench. TEM characterizations were performed with Philips EM400T/FEG, Philips EM430T and JEM 120C instruments.

38234 (CONF-860829—22) Site occupations in $L1_2$ ordered alloys by axial electron channeling microanalysis. Bentley, J. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 3p. (CONF-860854—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86009421.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Experiments using analytical electron microscopes were performed on Ni_3Al alloys with additions of Fe, Co, or Hf. Corrections had to be made for delocalization effects. Results agree with atom probe field-ion microscopy. (DLC)

38235 (CONF-860854—3) Radiation-induced segregation to grain boundaries in a Ni-Si alloy. Kesternich, W.; Packan, N.H.; Schroeder, H. (Oak Ridge National Lab., TN (USA); Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Festkoerperforschung). 1986. Contract AC05-84OR21400. 3p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010027.

From 11. international congress on electron microscopy; Kyoto, Japan (31 Aug 1986).

Solute transport by radiation-induced segregation (RIS) leads to local changes of alloy composition. We have studied RIS in a binary Ni-8 at. % Si alloy by 7-MeV-proton and 28-MeV-alpha particle irradiations. Damage levels varied between 0.1 and 0.3 dpa. The irradiations were carried out at 475°C, the expected peak RIS temperature; preimplantation of helium at 700°C was carried out in some specimens. Solute segregation was studied by energy-dispersive x-ray analysis (EDX). Using very fine electron-beam probes of 2 nm diameter from a high-brightness field-emission source, microchemical profiles across the grain boundaries were measured. Radiation-induced precipitation of Ni_3Si was investigated by dark-field transmission electron microscopy (TEM).

38236 (CONF-860879—1) Bainite in chromium-molybdenum steels. Klueh, R.L. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011781.

From International conference on martensitic transformations (ICOMAT-86); Nara, Japan (26 Aug 1986).

Classically, bainite is divided into an upper and lower variety, as distinguished by microstructural differences that are related to the isothermal-transformation temperature at which the bainite is formed. Two other microstructural variations have been proposed: granular (massive) and carbide-free acicular bainite. These varieties form more readily during a continuous cool. The effect of the bainite microstructure on mechanical properties was investigated. Carbide-free acicular and granular bainite were produced by varying the cooling rate from the austenitization temperature in a 3Cr-1.5Mo steel. A cooling rate of about 100°C/min produced acicular bainite and 7°C/min produced granular bainite. After tempering to a similar ultimate tensile strength (UTS), there were marked differences in the impact behavior of the acicular and granular bainite. The tempered acicular structure developed superior Charpy V-notch impact properties: an upper shelf energy of 225 J and a ductile-brittle transition temperature of -70°C for UTS of 770 MPa. Similar impact properties for the granular bainite were obtained only after the steel was tempered to a UTS of 590 MPa. Electron microscopy studies indicated that there were differences in the precipitate and dislocation distributions in the two bainite structures, which must cause the difference in properties.

38237 (DOE/ER/45098—11) Energetics of dislocation relaxation associated with cleavage in Cd-doped zinc crystals as probed by synchrotron topography. Schmitz, H.A.; Bilello, J.C.; Rek, Z. (State Univ. of New York, Stony Brook (USA). Dept. of Materials Science and Engineering; Stanford Univ., CA (USA). Stanford Synchrotron Radiation Lab.). 1986. Contract FG02-84ER45098. 38p. (CONF-860809—1). NTIS, PC A03/MF A01; GPO Dep. File Number DE86002968.

From International conference on low-energy dislocation structures; Charlottesville, VA, USA (10 Aug 1986).

An almost ten-fold increase in the cleavage energy of 0.1% Cd-doped zinc crystals has been previously reported in the literature and attributed to an increase in the intrinsic surface energy. The energetics of the cleavage process as a function of dopant concentration over the range 0.01, 0.03, 0.06 and 0.13% Cd has been systematically measured and correlated with the observed dislocation microstructure induced by crack initiation and growth. The dislocation relaxation zones were determined by nondestructive observations using synchrotron radiation topography. Since the primary cleavage and slip systems are co-planar, previous workers have ignored plastic relaxation and assumed fracture had to proceed in a purely brittle fashion. Synchrotron topography results indicated extensive plastic relaxation at the crack tip and also downstream during crack propagation. Based on these observations a modified Griffith analysis could be used to determine the relative contributions to the cleavage energy due to the intrinsic surface and dislocation relaxation processes. It was concluded that the latter process is the dominant factor in controlling the fracture toughness of these alloys.

38238 (EUR—9657/I-EN) Phase diagrams for Fe-Cr-Ni based alloys. Pt. 1. Phase diagrams for binary and ternary alloys of Fe, Cr and Ni with C and with Si. Ansara, I.; Chevalier, P.Y.; Chart, T.G.; Hack, K.; Spencer, P.J.; McHugh, G.; Rand, M.H. (Institut National Polytechnique, 38 - Grenoble (France); National Physical Lab., Teddington (UK); UKAEA Atomic Energy Research Establishment, Harwell). 1985. 136p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Physical sciences.

Phase diagrams for binary and ternary alloys of Fe, Cr and Ni with C and with Si have been evaluated from the basis of published experimental phase diagram and thermodynamic data. The relevant literature references are provided and short descriptions of the evaluation procedures used are given. Diagrams have been drawn to illustrate the evaluated phase equilibria in the temperature range 750 to 1500 K and thermochemical data in the form of equations are presented which permit calculation of the phase equilibria in each binary and ternary system. Nine binary and seven ternary systems are included in the evaluations. (orig.).

38239 (IFE/KR/E—85/004) Offshore use of titanium - benefits and possible limitations. Lunde, L. (Institute for Energy Technology, Kjeller (Norway)). 1985. 42p. (CONF-8504236—1). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752130.

From Nito seminar on advanced corrosion resistant steels and alloys for offshore applications; Oslo, Norway (24 Apr 1985).

The use of titanium in the oil industry has increased during the last decade and the material is now introduced in new and important applications offshore. About 100 units of titanium heat exchangers are now ordered or in operation in the Norwegian and the British sector of the North Sea. More than 20 units for hypochlorite production offshore have been installed in the last few years. The report summarizes properties of importance for offshore applications and describes titanium's benefits and possible limitations. The effect of design on the overall behaviour of heat exchangers with special focus on corrosion is discussed. The background for the gradual change from the traditional copper based alloys to titanium in seawater cooled heat exhangers are given. Other offshore applications of titanium is also described and future prospectives for new applications are briefly mentioned. The report concludes with information on availability and prices. 10 tables, 13 drawings.

38240 (Juel—1998) Neutron scattering on intermediate valence systems. Walter, U. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Festkoerperforschung; Koeln Univ. (Germany, F.R.)). Jun 1985. 162p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE86752086.

The temperature dependence of the magnetic relaxation line widths (quasielastic (QE) line widths) and the crystal field excitations of some novel intermediate valent systems were measured by means of inelastic neutron scattering. Some striking new features of the alloys $YbBe_{13}$, YbPd and Yb_3Pd_4 appoint them to belong to a new type of intermediate valent systems. $YbAl_3$ shows several inelastic lines, but no QE-line was measurable. The heavy fermion

systems $CeCu_6$ and URu_2Si_2 show a strongly temperature dependent QE-line width, in course of which $CeCu_6$ tends towards a nonvanishing residual value for T->0, which matches with theoretical predictions. For the first time valence instabilities of Pr (PrPd) and Sm (Smsub(0.51)Ysub(0.49)Al_3) could be proved by neutron scattering. In addition to these experiments, in $YbCu_2Si_2$ and TmTe the shifts in valency, caused by external hydrostatic pressure, were studied with a pressure cell for neutron scattering, especially designed and constructed for these special purposes. The corresponding observed changes of the QE-line widths coincide with the expected values, both in sign and absolute value. (orig.).

38241 (KFK—3971) Structural phase transitions in $HfV_2Hsub(x)$ and Zrsub(0.99)Hfsub(0.01)$V_2Hsub(x)$ observed in time differential perturbed angular correlation studies. Heidinger, R. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Genetik und Toxikologie von Spaltstoffen; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Physik). Aug 1985. 119p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752081.

The temperature dependence of electric field gradients was measured in the intermetallic compounds HfV_2 and Zrsub(0.99) Hfsub(0.01)V_2, their hydrides $HfV_2Hsub(x)$ (x=0.4, 1., 4.) and Zrsub(0.99) Hfsub(0.01)$V_2Hsub(x)$ (x=0.4, 1.3), and the deuterides $HfV_2Dsub(0.4)$ and Zrsub(0.99) Hfsub(0.01)$V_2Dsub(0.4)$. The measurement is based on the hyperfine interaction at the probe nucleus ^{181}Ta. These parameters allowed to follow the configurational changes with respect to the hafnium sites in a sensitive and quantitative manner. In Zrsub(0.99) Hfsub(0.01)V_2 the distortion of the cubic Laves phase was observed for the temperature range below 110(3) K. This finding is in accordance with neutron diffraction data. Furthermore a strong deviation from axial symmetry was measured. Thus a reduction of symmetry is indicated which exceeds the purely rhomboedric distortion so far resolved. For HfV_2 it is also inferred that symmetry is reduced to be not higher than orthorhombic. At room temperature the same perturbation of cubic symmetry was induced locally by neutron irradiation and demonstrated to be of high thermal stability. These results support the idea that the phase transition is due to a band Jahn-Teller effect. The values of the electric field gradients vary with a temperature dependence characteristic for order parameters. The related critical exponent classes the phase transition akin to 3-dimensional Ising models. In Zrsub(0.99) Hfsub(0.01) $V_2Hsub(0.4)$ / Dsub(0.4) hydrogen free domains were observed at low temperatures. Such fractions were not resolved for the other hydrides. The latter exhibit a transition from a low symmetric to a cubic structure at distinctly higher temperatures (above ca. 230 K). (orig./GSCH).

38242 (LA-UR—85-4231) Forward and reverse rearrangements of dislocations in cell walls. Hasegawa, T.; Yakou, T.; Kocks, U.F. (Los Alamos National Lab., NM (USA); Tokyo Univ. of Agriculture and Technology, Koganei (Japan). Dept. of Mechanical Engineering). 1985. Contract W-7405-ENG-36. 33p. (CONF-860809—2). NTIS, PC A03/MF A01; GPO Dep. File Number DE86004728.

From International conference on low-energy dislocation structures; Charlottesville, VA, USA (10 Aug 1986).

We consider the structure and properties of tangled cell walls: interconnected regions of finite thickness in which the dislocation density is high, but across which the misorientation is comparatively low. These are a prominent feature of the substructure of deformed metals, so long as strain, temperature, and stacking-fault energy do not have extremely low or extremely high values. These cell walls have an internal structure, including a polarity, that can be understood on the basis of a statistical/topological model of their original formation. Regardless of how such structures were formed, however, they are metastable and tend to rearrange themselves, under the action of stress, temperature and time, into lower-energy configurations. Some of these rearrangements are possible without the aid of diffusion. The associated glide is not randomly directed and therefore leads to macroscopic strain. The strain is in the same direction as that during the previous straining under which the cell structure was formed ("forward") in the case of recovery, but it is in the reverse direction upon unloading and reverse loading. In addition to the 'unpiling' of mobile dislocations commonly used to discuss reverse flow, we propose an 'untangling' of stored dislocations which, in the extreme, leads to the observed almost complete disintegration of the 'forward' cell structure at a critical reverse stress. Quantitative considerations lead to an explanation of the observed scaling laws for the Bauschinger effect.

38243 (LA-UR—86-796) Effect of residual strain on twinning in shock-loaded copper. Gray, G.T. III. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 3p. (CONF-860829—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86007362.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Under shock-loading, twinning is observed in metals that do not twin under conventional loading conditions, for example, copper and nickel where the stacking fault energy is about 78 and 128 $ergs/cm^2$, respectively. Contradictions in the published data on the twinning stress in copper (from 1.6 GPa in thin films to 14.5 to 20 GPa in bulk specimens) suggest differences associated with experimental techniques. This study examines the role of residual plastic strain (ϵ/sub res/) on the deformation substructures, particularly twinning, in shock-loaded copper.

38244 (LA-UR—86-797) Effect of strain and strain rate on residual microstructures in copper. Stevens, M.F.; Follansbee, P.S. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 3p. (CONF-860829—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86007361.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Several specimens of OFE Cu were deformed in compression to study the resulting microstructures at equivalent levels of threshold stress and strain. Equiaxed, diffuse dislocation cells are more persistent in Cu when tested at strain rates exceeding 10^3 sec^{-1}. At quasi-static strain rates, dislocation collapse into more distinct, narrow microbands occurs at lower strain levels.

38245 (LA-UR—86-2065) Mechanics of metal forming. Dawson, P.R.; Eggert, G.M.; Mathur, K.K. (Los Alamos National Lab., NM (USA); Cornell Univ., Ithaca, NY (USA)). 1986. Contract W-7405-ENG-36. 32p. (CONF-8606132—1). NTIS, PC A03/MF A01; GPO Dep. File Number DE86012414.

From 10. U.S. National Congress of Applied Mechanics conference; Austin, TX, USA (16 Jun 1986).

A metal forming model is outlined for analyzing large strain bulk operations such as forging, rolling, and drawing. Plastic deformations are assumed to be viscoplastic in that the strain rate dependent flow stress depends on the strain hardening through an internal variable that evolves with the deformations. Volumetric deformations are linked to the growth of voids (porosity) using a damage model in which the porosity serves as an internal variable. Several applications are presented that demonstrate by comparison to experimental data that the model can simulate effectively the response of a workpiece under realistic forming conditions.

38246 (LA-UR—86-2157) Muon spin relaxation and Knight shift in the heavy-fermion superconductor UPt_3. Cooke, D.W.; Heffner, R.H.; Hutson, R.L.; Schillaci, M.E.; Smith, J.L.; Willis, J.O.; MacLaughlin, D.E.; Boekema, C.; Lichti, R.L.; Denison, A.B. (Los Alamos National Lab., NM (USA); California Univ., Riverside (USA); San Jose State Univ., CA (USA); Texas Tech Univ., Lubbock (USA); Wyoming Univ., Laramie (USA); Cincinnati Univ., OH (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-8606134—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012398.

From 4. international conference on muon spin rotation, relaxation and resonance; Uppsala, Sweden (1 Jun 1986).

Positive muon spin relaxation experiments have been conducted on the heavy-fermion superconductor UPt_3 in both the normal and superconducting states for zero, transverse, and longitudinally applied magnetic fields. Below 6 K in zero applied field, the μ^+ relaxation rate is approximately twice that expected from ^{195}Pt nuclear dipolar relaxation alone. Transverse- and longitudinal-field

measurements show that the observed relaxation rate depends on magnetic field and is quasistatic in origin. It is suggested that the onset of very weak ($\sim 10^{-2}$ μ/sub B//U atom) magnetic ordering below approximately 6 K is responsible for the observed increase in the relaxation rate. μ^+ Knight shift measurements in the normal state of UPt_3 show a temperature dependent shift K/sub μ/ which tracks the bulk susceptibility chi. From the K/sub μ/ vs chi plot, a μ^+ hyperfine field of approximately 100 Oe/μ/sub B/ is extracted.

38247 (LA-UR—86-2199) Heavy fermion materials. Smith, J.L.; Cooke, D.W. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 6p. (CONF-8606134—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012435.

From 4. international conference on muon spin rotation, relaxation and resonance; Uppsala, Sweden (1 Jun 1986).

The heavy-fermion ground state occurs in a few select metallic compounds as a result of interactions between f-electron and conduction-electron spins. A characteristically large electronic heat capacity at low temperature indicates that the effective electron mass of these materials is more than two orders of magnitude greater than that expected for a free-electron metal. This heavy-fermion ground state can become superconducting or antiferromagnetic, exhibiting very unusual properties. These materials and the role of muon spin rotation in their study are briefly discussed.

38248 (LBL—21287) Atomic resolution study of precipitates in an Al-Ge alloy. Dahmen, U.; Nelson, C.; Westmacott, K.H. (Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098. 5p. (CONF-860829—27). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011308.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

The difficulty of precipitating germanium in dilute aluminum-germanium alloys is due to a large difference in crystal structures (face-centered cubic and diamond cubic) accompanied by a substantial volume expansion of 36%. A great variety of precipitate morphologies and orientation relationships are observed. A frequently found morphology is that of <100> needles. By selected area diffraction and Moire fringes it has been established that <100> Al and <110> Ge are parallel along the needle axis. The typical aspect ratio of about 100 has made it difficult in the past to investigate the cross-sectional shape and internal structure of these needles, although some indications of internal twinning were found in plates. In the present work, the Berkeley Atomic Resolution Microscope was used to examine needles in cross section by imaging along the <110> Ge <100> Al needle axis.

38249 (LBL—21468) Local surface structures of c(2 x 2) S/Ni(011) and (2 x 2) S/Ge(111) determined using ARPEFS. Robey, S.W. (Lawrence Berkeley Lab., CA (USA)). Apr 1986. Contract AC03-76SF00098. 160p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86012495.

; Thesis.

Angle-resolved photoemission extended fine structure (ARPEFS) measurements were performed on the c(2 x 2) S/Ni(011) and (2 x 2) S/Ge(111) systems. The S/Ni(011) system was studied to assess the extent to which surface structural information can be obtained from ARPEFS and to provide a large data set for comparison to recently developed multiple-scattering calculations. An expansion of the first Ni interplanar separation (11%) previously indicated by ion scattering experiments was confirmed, and a further reconstruction consisting of a buckled second Ni layer was suggested the S/Ge(111) study. Results of the ARPEFS investigation on the S/Ge(111) system indicate that sulfur adsorbs on Ge(111) in a 2-fold bridge site, 1.03 +- 0.05 A above the first Ge layer. This is different from the site determined for Te/Ge(111), but agrees with the adsorption sites proposed for Te/Si(111) and Se/Si(111). The data also indicate a contraction (9%) in the first interplanar separation (the separation of the two components of the first bilayer), and an expansion of 7 +- 3% in the bond lengths between the Ge bilayers (2.60 to 2.65 A versus a bulk value of 2.45 A). This last result applies to the bonds which are most nearly below the 2-fold adsorption site.

38250 (N—86-20495) Advanced turbine study. Final Report, 1 August 1982-15 August 1985. Castro, J.H. (Pratt and Whitney Aircraft Group, West Palm Beach, FL (USA)). Dec 1985. 188p. (FR—19009-1). NTIS, PC A09/MF A01.

The feasibility of an advanced convective cooling concept applied to rocket turbine airfoils which operate in a high pressure hydrogen and methane environment was investigated. The concept consists of a central structural member in which grooves are machined. The grooves are temporarily filled with a removable filler and the entire airfoil is covered with a layer of electroformed nickel or nickel base alloy. After removal of the filler, the low thermal resistance of the nickel closure causes the wall temperature to be reduced by heat transfer to the coolant. The program is divided in the following tasks: (1) turbine performance appraisal; (2) coolant geometry evaluation; (3) test hardware design and analysis; and (4) test airfoil fabrication.

38251 (N—86-20586) Growth of high-quality thin-film Ge single crystals by plasma-enhanced chemical vapor deposition. Outlaw, R.A.; Hopson, P. Jr. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Feb 1986. 15p. (L—16011). NTIS, PC A02/MF A01.

Thin-film Ge single crystals (approx. 10 microns) have been epitaxially grown on polished NaCl(100) substrates at 450C by using plasma-enhanced chemical vapor deposition. Films on approximately 1 sq cm and larger were separated from the NaCl by either melting the salt or by differential shear stress upon cooling to room temperature. The ordered growth of the Ge was found to be most sensitive to the initial plasma power and to the continuum flow dynamics within the carbon susceptor. The films were visually specular and exhibited a high degree of crysalline order when examined by x-ray diffraction. The films were found to be p-type with a carrier concentration of approximately 3 x 10 to the 16th power/cu cm, a resistivity of 0.11 ohm-cm, and a Hall hole mobility of 1820 sq cm/v/s at room temperature. Vacuum firing minimized the primary contaminant, Na, and corresponding lowered the carrier concentration to 4 x 10 to the 14th power/cu cm.

38252 (N—86-21658) Role of molybdenum in the Na_2SO_4 induced corrosion of superalloys at high temperatures. Misra, A.K. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 29p. (NASA-TM—87235; E—2905; CONF-860340—5). NTIS, PC A03/MF A01.

From 115. American Institute of Mining, Metallurgical and Petroleum Engineers annual meeting; New Orleans, LA, USA (2 Mar 1986).

Sodium sulfate induced corrosion of a molybdenum containing nickel-base superalloy, Udimet 700, was studied in laboratory furnace tests and in a high velocity (Mach 0.3) burner rig. The effect of SO_3 content in the atmosphere on the corrosion behavior in the laboratory furnace tests was determined. Catastrophic corrosion occurs only when the melt contains MoO_3 in addition to Na_2SO_4 and Na_2MoO_4. The conditions under which catastrophic corrosion occurs are identified and a mechanism is described to explain the catastrophic corrosion.

38253 (NUREG/CR—4241) Chemical aspects of cesium iodide interaction in steam with 304 stainless steel and Inconel-600. Sallach, R.A. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 48p. (SAND—84-0749). NTIS, PC A03/MF A01 - GPO. File Number TI86012613.

While being oxidized by steam at 1273°K the alloys 304 stainless steel and Inconel-600 were exposed to CsI vapor. The chemical data from subsequent analyses are presented and discussed. Some cesium, but not iodine, was retained on the oxide formed on Inconel-600. There is a moderate correlation of cesium with the silicon content of the oxide (correlation coefficients near 0.7) but no correlation with any other element. Formation of a cesium silicate is indicated. No cesium or iodine was detected in the oxide layers formed on 304 stainless steel, in sharp contrast to previous experiments with CsOH vapor.

38254 (ORNL/M—1/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Shielded metal arc welding of carbon steel. Wodtke, C.H.; Frizzell, D.R.; Mitchell, J.H. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012535.

Procedure WPS-101-ASME-2 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for shielded metal arc welding of carbon steels (P-1-1), in thickness range 0.125 to 0.75 inch; filler metal is E6010 (F-3, A-1).

38255 (ORNL/M—2/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc welding of carbon steel. Wodtke, C.H.; Frizzell, D.R.; Mitchell, J.H. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012534.

Procedure WPS-103-ASME-3 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of carbon steel (P-1-1), in thickness range 0.035 to 1.0 inch; filler metal is ER70S-3 (F-6, A-1); shielding gas is argon.

38256 (ORNL/M—3/S1) Gas tungsten arc and shielded metal arc welding of carbon steel. Welding procedure specification. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012533.

Procedure WPS-104-ASME-2 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc and shielded metal arc welding of carbon steels (P-1-1), in thickness range 0.25 to 1.0 inch; filler metals are E70S-3 (F-6, A-1) (GTAW) and E6010 (F-3, A-1) (SMAW): shielding gas is argon (GTAW).

38257 (ORNL/M—4/S1) Welding procedure specification: manual gas tungsten arc and semiautomatic gas metal arc welding of carbon steel. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012532.

Procedure WPS-107-ASME-1 is qualified under Section IX of the ASME Boiler and Vessel Code for manual gas tungsten arc and semiautomatic gas metal arc welding of carbon steel (P-1-1), in thickness range of 0.237 to 2.0 inch; filler metal is ER70S-3 (F-6d, A-1); shielding gas for GTAW is argon and for GMAW is 95-5 argon-oxygen.

38258 (ORNL/M—5/S1) Welding procedure specification: semiautomatic gas metal arc welding of carbon stees. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012531.

Procedure WPS-109-ASME-2 is qualified under Section IX of the ASME Boiler and Vessel Code for semiautomatic gas metal arc welding of carbon steel (P-1-1), in thickness range 0.187 to 2.0 inch; filler metal is ER70S-3 (F-6, A-1); shielding gas is 95-5 argon-oxygen.

38259 (ORNL/M—6/S1) Machine gas metal arc welding of carbon steel. Welding procedure specification. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012530.

Procedure WPS-110-ASME-1 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for machine gas metal arc welding of carbon steels (P-1-1); in thickness range 0.280 to 0.75 inch; filler metal is E70S-3 (F-6, A-1); shielding gas is 95-5 argon-oxygen.

38260 (ORNL/M—10/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc and shielded metal arc welding of AISI 41XX steels. Wodtke, C.H.; Frizzell, D.R. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012526.

Procedure WPS-127 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc and shielded metal arc welding of AISI 4130 and 4142 steels (ASTM A519) (P-No: None), 0.438-inch wall pipe; filler metal is AMS 6457, Class 4130 MC (F-, A-No: None) (GTAW) and E8018-B2L (F-4, A-3) (GMAW): shielding gas is argon (GTAW).

38261 (ORNL/M—11/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc and low hydrogen shielded metal arc welding of carbon steel. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012525.

Procedure WPS-128-ASME-1 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc and low hydrogen shielded metal arc welding of carbon steels (P-1-1), in thickness range 0.25 to 2.0 inch; filler metals are ER70S-3) (F-6, A-1) (GTAW) and E7018 (F-4, A-1); shielding gas is argon (GTAW).

38262 (ORNL/M—12/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Shielded metal arc welding of chromium-nickel steel. Wodtke, C.H.; Frizzell, D.R.; Mitchell, J.H. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012524.

Procedure WPS-301-ASME-3 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for shielded metal arc welding of 300 Series Cr-Ni steels (P-8-1), in thickness range 0.125 to 2.0 inch; filler metal is E3XX-15 (F-5, A-8).

38263 (ORNL/M—15/S1) Welding procedure specification: manual gas tungsten arc and semiautomatic gas metal arc welding of chromium-nickel steel. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 15p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012521.

Procedure WPS-306-ASME-6 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for manual gas tungsten arc and semiautomatic gas metal arc welding of 300 Series Cr-Ni steels (P-8-1), in thickness range 0.375 to 2.0 inch; filler metal is ER3XX (F-6, A-8); 1 shielding gases are argon (GTAW) and 98-2 argon-oxygen.

38264 (ORNL/M—17/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Manual gas tungsten arc and machine gas metal arc welding of chromium-nickel steel. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012519.

Procedure WPS-308-ASME-0 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for manual gas tungsten arc and machine gas metal arc welding of 300 Series Cr-Ni steels (P-8-1), in thickness range 0.037 to 2.0 inch; filler metal is ER3XX (F-6, A-8); shielding gases are argon (GTAW) and 98-2 argon-oxygen (GMAW).

38265 (ORNL/M—18/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Machine gas tungsten arc and machine gas metal arc welding of chromium-nickel steel. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012518.

Procedure WPS-309-ASME-0 is qualified under Section IX of the ASME Boiler and Pressure Vessel code for machine gas tungsten arc and machine gas metal arc welding of 300 Series Cr-Ni steels (P-8-1), in thickness range 0.375 to 2.0 inch; filler metal is ER3XX (F-6, A-8); shielding gases are argon (GTAW) and 98-2 argon-oxygen (GMAW).

38266 **(ORNL/M—19/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc welding of austenitic chromium-nickel steel.** Wodtke, C.H.; Frizzell, D.R. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012517.

Procedure WPS-310 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of Type 309 and Type 310 austenitic stainless steels (P-8-2), in thickness range 0.029 to 0.625 inch; filler metals are ER309 (F-6, A-8) and ER310 (F-6, A-9) respectively; shielding gas is argon.

38267 **(ORNL/M—20/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Semiautomatic gas metal arc welding of chromium-nickel steel.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012516.

Procedure WPS-315-ASME-1 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for semiautomatic gas metal arc welding of 300 series Cr-Ni steels (P-8-1), in thickness range 0.25 to 1.0 inch; filler metal is ER3XX (F-6, A-8); shielding gas is 98-2 argon-oxygen.

38268 **(ORNL/M—24/S1) Gas tungsten arc welding of aluminum alloys 6XXX. Welding procedure specification. Supplement 1. Records of procedure qualification tests.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 23p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012548.

Procedure WPS-1003 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of aluminum alloys 6061 and 6063 (P-23), in thickness range 0.035 to 0.516 inch; filler metal is ER4043 (F-23) or ER5356 (F-22); shielding gas is argon.

38269 **(ORNL/M—25/S1) Welding procedure specification: gas tungsten arc dc welding of aluminum alloys 6XXX. Supplement 1. Records of procedure qualification tests.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012547.

Procedure WPS-1007 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of aluminum alloys 6061 and 6063 (P-23), in thickness range 0.125 to 2.0 inch; filler metal is ER4043 (F-23); current is direct, shielding gas is helium.

38270 **(ORNL/M—26/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Manual gas tungsten arc (DC) and semiautomatic gas metal arc welding of 6XXX aluminum.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012546.

Procedure WPS-1009 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for manual gas tungsten arc (DC) and semiautomatic gas metal arc (DC) welding of aluminum alloys 6061 and 6063 (P-23), in thickness range 0.187 to 2,0 inch; filler metal is ER4043 (F-23); shielding gases are helium (GTAW) and argon (GMAW).

38271 **(ORNL/M—27/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Semiautomatic gas metal arc welding of 6XXX aluminum.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012545.

Procedure WPS-1015 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for semiautomatic gas metal arc welding of aluminum alloys 6061 and 6063 (P-23), in thickness range 0.187 to 2.0 inch; filler metal is ER4043 (F-23); shielding gas is argon.

38272 **(ORNL/M—28/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc welding of copper.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012544.

Procedure WPS-1101 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of copper alloys C10200, C10400, C10500, C10700, C12000, C12200, and C12300 (P-31), in thickness range 0.125 to 1.0 inch; filler metal is ERCu (F-31); shielding gas is helium.

38273 **(ORNL/M—29/S1) Welding procedure specification: gas tungsten arc welding of nickel. Supplement 1. Records of procedure qualification tests.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012543.

Procedure WSP-1301-ASME-4 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of nickel NO2200 and NO2201 (P-41), in thickness range 0.035 to 0.432 inch; filler metal is ERNi-1 (F-41); shielding gas is argon.

38274 **(ORNL/M—30/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc welding of nickel-copper.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012542.

Procedure WPS-1302-ASME-3 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of nickel-copper NO4400 (P-42), in thickness range 0.035 to 0.432 inch; filler metal is ERNiCu-7 (F-42); shielding gas is argon.

38275 **(ORNL/M—31/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc welding of nickel-chromium-iron and nickel-chromium molybdenum.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012541.

Procedure WPS-1303-ASME-8 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of nickel-chromium-iron, NO6600 (P-43), with filler metal ERNiCrFe-5 (F-43); and nickel-chromium-molybdenum, NO6625 (P-43), with filler metal ERNiCrMo-3 (F-43); in thickness range 0.020 to 0.432 inch; shielding gas is argon.

38276 **(ORNL/M—32/S1) Welding procedure specification: gas tungsten arc welding of nickel-molybdenum or nickel-molybdenum-chromium (Hastelloy B and C). Supplement 1. Records of procedure qualification tests.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012540.

Procedures WPS-1401-ASME-2 is qualified under Section IX of the ASME Boiler and pressure Vessel Code for gas tungsten arc welding of 28 Mo-5Fe, 15.5 Cr-16Mo-3.5W and low C-16 Mo-

16 Cr-5.5Fe (P-44), in thickness range 0.035 to 0.432d inch; filler metals are respectively ERNiMo-1, ERNiCrMo-5, and ERNiCrMo-4 (F-44); shielding gas is argon.

38277 (ORNL/M—33/S1) Welding procedure specification: gas tungsten arc welding of nickel-molybdenum-chromium-iron. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 26p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012539.

Procedure WSP-1402-ASME-5 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of nickel-molybdenum-iron, with or without 2% Ti, (P-44), in thickness range 0.042 to 2.0 inch; filler metal is ERNiMo-2 (F-44) or special alloy with 2% Ti; shielding gas is argon.

38278 (ORNL/M—34/S1) Welding procedure specification: gas tungsten arc welding of carbon steel to chromium-nickel steel. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012538.

Procedure WPS-2102-ASME-2 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of carbon steel (P-1-1) to 300 series Cr-Ni steels (P-8-1), in thickness range 0.035 to 1.0 inch; filler metal is ERNiCr-3 (F-43); shielding gas is argon.

38279 (ORNL/M—35/S1) Welding procedure specification: gas tungsten arc and shielded metal arc welding of carbon steel. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012537.

Procedure WPS-2103-ASME-1 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc and shielded metal arc welding of carbon steels (P-1-1) to 300 series Cr-Ni steels (P-8-1), in thickness range 0.25 to 2.0 inch; filler metals are ERNiCr-3 (F-43 (GTAW) and ENiCrFe-3 (F-43) (SMAW); shielding gas is argon (GTAW).

38280 (ORNL/M—36/S1) Welding procedure specification: gas tungsten arc welding of chromium-nickel steel to chromium-molybdenum steel. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012536.

Procedure WPS–2104-ASME-1 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of 300 series Cr-Ni steels (P-8-1) to 2 1/4-1Mo steels (P-5-1), in thickness range 0.187 to 1.0 inch; filler metal is ERNiCr-3 (F-43); shielding gas is argon.

38281 (ORNL/M—39/S1) Gas tungsten arc welding of aluminum alloys 3004, 5052, and 5x54 to 6xxx. Welding procedure specification. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012561.

Procedure WPS-2203 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of aluminum alloys 3004, 5052, 5154, and 5454 (P-22) to 6061 and 6063 (P-23), in thickness range 0.062 to 0.5 inch; filler metal is ER4043 (F-23); shielding gas is argon.

38282 (ORNL/M—43/S1) Welding procedure specification: gas tungsten arc welding of nickel tonickel-chromium-iron. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 19p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012557.

Procedure WPS-2302-ASME-3 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of nickel N02200 or N02201 (P-41) to nickel-chromium-iron N06600 (P-43), in thickness range 0.035 to 0.432 inch; filler metal is ERNiCrFe-5 (F-43); shielding gas is argon.

38283 (ORNL/M—44/S1) Welding procedure specification: gas tungsten arc welding of nickel-copper to nickel-chromium-iron. Supplement 1. Records of procedure qualification tests. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012556.

Procedure WPS-2303-ASME-3 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of nickel-copper N04400 (P-42) to nickel-chromium-iron N06600 (P-43), in thickness range of 0.035 to 0.432 inch; filler metal is ERNiCu-7 (F-42); shielding gas is argon.

38284 (ORNL/M—46/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc welding of nickel-chromium-iron to nickel-molybdenum-chromium-iron. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012554.

Procedure WPS-2305-ASME-3 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of nickel-chromium-iron (P-43) to nickel-molybdenum-chromium-iron (P-44), in thickness range 0.062 to 0.5 inch; filler metal is ERNiCr-3 (F-43); shielding gas is argon.

38285 (ORNL/M—47/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc welding of chromium-nickel steel to nickel. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012553.

Procedure WPS-2601-ASME-3 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of 300 series Cr-Ni steels (P-8-1) to nickel N02200 or N02201 (P-41), in thickness range 0.035 to 0.432; filler metal is ERNi-Cr-3 (F-43); shielding gas is argon.

38286 (ORNL/M—48/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc welding of chromium-nickel steel to nickel-copper. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012552.

Procedure WPS-2602-ASME-3 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of 300 series Cr-Ni steels (P-8-1) to nickel-copper N04400 (P-42), in thickness range 0.035 to 0.432 inch; filler metal is ERNiCu-7 (F-42); shielding gas is argon.

38287 (ORNL/M—49/S1) Welding procedure specification. Supplement 1. Records of procedure qualification tests. Gas tungsten arc welding of chromium-nickel steel to nickel-chromium-iron. Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012551.

Procedure WPS-2603-ASME-6 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of 300 series Cr-Ni steels (P-8-1) to nickel-chromium-iron

(P-43), in thickness range 0.020 to 0.432 inch; filler metal is ERNiCr-3 (F-43); shielding gas is argon.

38288 **(ORNL/M—50/S1) Gas tungsten arc welding of chromium-nickel steel to nickel-molybdenum-chromium-iron. Welding procedure specification. Supplement 1. Records of procedure qualification tests.** Wodtke, C.H.; Frizzell, D.R.; Plunkett, W.A. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012550.

Procedure WPS-2604-ASME-5 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of 300 series Cr-Ni steels (P-8-1) to nickel-molybdenum-chromium-iron (P-44), in thickness range 0.035 to 0.5 inch; filler metal is ERNiCr-3 (F-43); shielding gas is argon.

38289 **(ORNL/M—51/S1) Gas tungsten arc welding of carbon steel to nickel-chromium-iron. Welding procedure specification. Supplement 1. Records of procedure qualification tests.** Wodtke, C.H.; Frizzell, D.R. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012549.

Procedure WPS-2651-ASME-1 is qualified under Section IX of the ASME Boiler and Pressure Vessel Code for gas tungsten arc welding of carbon steel (P-1-1) to nickel-chromium-iron (P-43), in thickness range 0.125 to 0.432 inch; filler metal is ERNiCr-3 (F-43); shielding gas is argon.

38290 **(PB—86-193687/XAB) Laboratory study to evaluate the impact of NOx, SOx, and oxidants on the atmospheric corrosions of galvanized steel.** Edney, E.O.; Stiles, D.C.; Spence, J.W.; Haynie, F.H.; Wilson, W.E. (Northrop Services, Inc., Research Triangle Park, NC (USA)). May 1986. 34p. NTIS, PC A03/MF A01.

A series of laboratory experiments was conducted in which galvanized steel exposed to NO_2 in air and irradiated propylene/nitrogen oxides/air mixtures in the absence and presence of SO_2. Dew was produced periodically on the test panels, and at the end and/or during the experiments, panels were sprayed with either deionized water or an ammonium bisulfate solution (pH of 3.5). Gas-phase concentrations were monitored, and dew and rain-rinse samples were analzed for nitrite, nitrate, sulfite, sulfate, formaldehyde, and zinc. The average deposition velocities measured during periods of wetness were sulfur dioxide, 0.8 cm/s; formaldehyde, 0.6 cm/s; nitric acid, 0.7 cm/s; and nitrogen dioxide, 0.03 cm/s. Analysis of dew samples suggests that the dry deposition of sulfur dioxide, nitric acid, formaldehyde, and possibly nitrogen dioxide accelerates the atmospheric corrosion of galvanized steel. Wet deposition of acidic species accelerates corrosion. A general model for the atmospheric corrosion of galvanized steel is presented.

38291 **(PNL-SA—13513) Effect of irradiation temperature and oxygen impurity on the yield strength of T(d,n) neutron irradiated niobium.** Bradley, E.R.; Jones, R.H. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 13p. (CONF-860421—54). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011619.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Tensile tests and microstructural examinations have been conducted on niobium wires and foils with differing oxygen contents following T(d,n) neutron irradiation at 300 K, 475 K, and 675 K. The yield strength of the irradiated wires was strongly dependent on both oxygen content and irradiation temperature. Increasing the oxygen content from 185 to 480 wppM produced 1.6 to 2.0 times greater increases, $\Delta\sigma$, in the measured yield strength for samples irradiated at the same temperature to a fluence of ~5 x $10^{21} m^{-2}$. Maximum strengthening was observed following irradiation at 475 K where measured yield strength increases were at least a factor of 3 greater than for samples with similar oxygen contents irradiated at 300 K. Irradiation at 675 K produced 30 to 60% more strengthening at 5 x $10^{21} m^{-2}$ than irradiation at 300 K. Correlations between the measured yield strength and microstructural data suggest that oxygen impurities interact with the irradiation produced defects during irradiation at 475 K which results in more effective obstacles to dislocation motion and consequently greater strengthening.

38292 **(PNL-SA—13913) Effect of irradiation on carbide evolution in a pure Fe-2-1/4Cr-1Mo ferritic alloy.** Brimhall, J.L.; Simonen, E.P. (Pacific Northwest Labs., Richland, WA (USA)). Mar 1986. Contract AC06-76RL01830. 16p. (CONF-860605—16). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012326.

From 13. international symposium on the effects of radiation on materials; Seattle, WA, USA (23 Jun 1986).

Ion irradiation was observed to accelerate the kinetics of the carbide evolution in a "pure" Fe-2-1/4Cr-1Mo steel. The type and structure of the phases were unchanged by irradiation compared to thermal annealing. The transformation kinetics of Fe_3C to M_7C_3 and the independent nucleation of M_2C were both enhanced by the ion irradiation. The observed irradiation enhancement of the kinetics however did not follow a predicted trend based on a simple radiation enhanced diffusion model. There is no obvious explanation for this discrepancy except that mechanisms in addition to enhanced diffusion influence the complex transformation process.

38293 **(SAND—86-0251C) Initation of pitting corrosion in martensitic stainless steels.** Cieslak, W.R.; Semarge, R.E.; Bovard, F.S. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 11p. (CONF-860829—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007627.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

The form of localized corrosion known as pitting often initiates preferentially at microstructural inhomogeneities. The pit initiation resistance, therefore, is controlled by the characteristics of the initiation sites, rather than by the bulk material composition. This investigation correlates the pit initiation resistance, as measured by critical pitting potentials, with preferred pit initiation sites for 3 martensitic stainless steels. Pit initiation sites are determined by secondary electron (SE) and backscattered electron (BSE) imaging and energy dispersive and wavelength dispersive spectrometries (EDS and WDS) with a scalling electron microscope (SEM) and an electron probe microanalyzer (EPMA).

38294 **(SAND—86-0567C) Electron diffraction analysis of the pentagonal arrangement of grains found in CVD pure Ni films.** Campbell, A.N.; Carr, M.J.; VanderSande, J.B. (Sandia National Labs., Albuquerque, NM (USA); Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Materials Science and Engineering). 1986. Contract AC04-76DP00789. 3p. (CONF-860829—16). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009023.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

The structure of each crystal in the pentagon is fcc, as verified by diffraction patterns from individual grains. It is suggested that the large pentagonal regions observed were nucleated by small decahedral clusters of Ni atoms during the early stages of the deposition. However, for grains as large as those shown the body centered orthorhombic structure is not stable; at some point during the growth process the crystal structure reverted to the energetically preferred fcc. The relative orientation between the individual crystals, having been established by the decahedral nucleus, was preserved during growth. The 7.5° mismatch was taken up evenly around the pentagon by the formation of dislocations and/or secondary twins at the boundaries.

38295 **(SAND—86-0779C) Electron spectroscopy in fundamental catalytic studies.** Goodman, D.W.; Houston, J.E. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 12p. (CONF-860829—11). NTIS, PC A02/MF A01; GPO Dep. File Number DE86008781.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

A detailed understanding of the chemical nature of surface impurities and overlayers is critical to many technologically important phenomena. Modern surface spectroscopies provide us with the capability to probe many subtleties of surface/adsorbate systems and have proved to be invaluable to the development of our understanding of surface catalyzed reactions and related phenomena. This paper illustrates this point with two specific examples, the production of surface carbon in catalytic methanation over nickel and the modification of electronic properties of copper by an underlying ruthenium substrate.

38296 **(SAND—86-0812C) Microstructural study of high energy density dissimilar metal welds.** Cieslak, M.J.; Hills, C.R.; Headley, T.J. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 15p. (CONF-860829—17). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009284.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Electron microscopy analysis of two different CO_2 laser welded dissimilar metal combinations revealed the presence of minor constituents which could be attributed to terminal solidification events. In the case of the 15-5 PH/HP 9-4-20 welds, a NbC/austenite eutectic-type constituent was identified, which accounted for the observed fusion-zone hot cracks in these welds. The identity of the interdendritic constituent first observed optically by Patterson and Milewski[8] in 304L/625 GTA welds has been confirmed as Laves phase. It was further determined that this phase is enriched in Mo and Nb relative to the austenite matrix.

38297 **(SAND—86-0975C) Microstructural analysis of alloy 718 welds to Kovar and 304L.** Knorovsky, G.A.; Headley, T.J. (Sandia National Labs., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 14p. (CONF-860829—24). NTIS, PC A03. File Number DE86010468.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Hermetic miniature electromechanical and electrochemical components require headers containing glass-to-metal seals through which electrical feedthroughs are made. Recent developments in glass-ceramic technology have provided a high-strength, high-corrosion-resistance lithium aluminosilicate glass-ceramic which is compatible with Alloy 718 (Ni-18.6Cr-18.5Fe-5Nb-3.1Mo-0.9Ti-0.4Al). This material combination offers designers a high strength header option they have not previously had available. To take advantage of this option, however, one must be able to closure weld the header to various structural materials commonly used in these applications. This study reports on the correlation between weld microstructure determined via Analytical Electron Microscopy (AEM) and weldability ratings given by the Varestraint Test for dissimilar welds involving Alloy 718 and either Kovar (Fe-29Ni-17Co) or 304L (Fe-18Cr-10Ni-<0.03C) stainless steel.

38298 **(STF—16A85030) Microbiological corrosion in an aqueous environment. Final report.** Steinsmo, U. (SINTEF, Trondheim (Norway)). 1985. 9p. (In Norwegian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752131.

In spring 1983 SINTEF initiated a preliminary project on microbiological corrosion in aqueous environment. The general aim was to increase knowledge on the basic conditions and mechanisms for such microbiological corrosion and to produce a survey of the experiences in this area up to the present date with a long term experimental project in mind. The results of the investigations are briefly summarized and concern mainly rust tubercles caused by microorganisms. The iron bacteria Gallionella, is found to be most corrosive but the full mechanism is not clear. Detailed information is given in reports written in connection with the project. A list of them is included. 7 references.

38299 **(STU—81-5753) Corrosion/erosion of materials for fluidized bed combustion.** Haeggblom, E. (National Swedish Board for Technical Development, Stockholm; Studsvik Energiteknik AB, Nykoeping (Sweden)). Jan 1984. 24p. (STUDSVIK-EI—84-23). Haeggblom, Studsvik Energiteknik AB, S-611 82 Nykoeping, Sweden.

Uncooled specimens of low alloyed steels, ferritic and austenitic stainless steels as well as nickel and cobalt base alloys, have been tested in a 16 MW AFBC for about 500 h. Ferritic steels with 9 - 18 % Cr and 1 -2 % Mo developed very thick oxide scales. AISI 310 and Inconel 601 got deep intergranular attacks. Best results had AISI 347H, Haynes alloy no 25 and Inconel 625. The project also includes cooled specimens, but they are still in the combustor. Some alloys were also tested in a laboratory erosion/corrosion equipment at different temperatures, atmospheres and particle velocities. Hitherto the results of the lab tests and the full scale tests do not correspond well, probably due to higher erosion/corrosion ratio in the former. Also the lab tests will be continued. (Author).

38300 **(STU—83-5004) Mechanisms and models for the stress corrosion cracking of stainless steels. A literature survey.** Jargelius, R.; Lindenmo, M. (National Swedish Board for Technical Development, Stockholm). May 1985. 260p. (In Swedish). (JKF-D—540; IM—1964). NTIS (US Sales Only), PC A12/MF A01. File Number DE86752155.

In spite of much research over the last 30 years, the mechanism(s) for the stress corrosion cracking (SCC) of stainless steels is still unclear. None of the existing mechanisms can explain all the accumulated experimental data. The film rupture and hydrogen embrittlement mechanisms have attracted the greatest interest. According to the film rupture mechanism, SCC is caused by repeated rupture of the passive film at the crack tip, followed by anodic dissolution. According to the hydrogen embrittlement mechanism hydrogen absorption at the crack tip leads to brittle fracture and hence the propagation of a stress corrosion crack. A number of experimental observations have been interpreted as supporting or disproving one or the other mechanism. Quantitative treatments of SCC, primarily based on the film rupture mechanism, give a relatively good agreement between calculated and observed parameters, but only in a few, very limited metal-environment systems. The mechanisms described in this study include active path corrosion, tunneling, film rupture, hydrogen embrittlement and film-induced cleavage. The experimental results and arguments both for and against the various mechanisms are discussed in detail. In particular, the effects of polarisation, fractography, dislocation structure, metallurgical variables and phase transformations are considered. 274 references, 12 tables, 151 figures.

38301 **(SVF—192) Corrosion inhibitors for intermediate cooling systems.** Falk, I.; Suhr, L. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Apr 1985. 50p. (In Swedish). (STUDSVIK-EB—83-69). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752147.

The selected inhibitors were tested for heat and radiation stability and corrosion protection on the bench scale. Based on the results from these tests two of the products were selected, Bycoguard 81 and Bycoguard MP4S for continuing corrosion tests in an autoclave loop at 90 degrees C and 120 degrees C. Oxygen saturated deionized water with an addition of 1 ppm chloride was recirculated in the loop. Samples of copper and carbon steel were exposed to the water in the autoclave for periods up to 10 weeks. The purpose of this project was to find a substitute for hydrazine and chromates. Besides good corrosion protection qualities the toxic and environmental effect of the inhibitors should be minimal. The investigation has shown that the copper inhibitor BTA (benzotriazole) loses its corrosion protection qualities at a water temperature of 120 degrees C. The protection effects at 90 degrees C were satisfactory for both of the materials. The corrosion rates measured were 0.01 mm/y or less for the copper and carbon steel samples. The environment in the autoclave during the testing was more corrosive than is to be found in intermediate cooling systems. Due to the low corrosion rates measured the two inhibitors are to be recommended as alternatives to hydrazine and chromates.

36302 (Y—2355) Computer simulation of immersion quenching of uranium-0.75 wt % titanium alloy cylinders. Llewellyn, G.H.; Aramayo, G.A.; Siman-Tov, M.; Childs, K.W.; Ludtka, G.M. (Oak Ridge Y-12 Plant, TN (USA)). 30 Jun 1986. Contract AC05-84OS21400. 136p. NTIS, PC A07/M A01; 1; GPO Dep. File Number DE86012468.

It is found feasible for the analytical simulation of the complex quenching process of the U-0.75 Ti alloy. The models developed can be used as a basis to understand, study, and optimize the process. Information obtained from these models can be used to analytically predict temperature distribution, cooling rates, stresses, deformation, phase composition, and possibly void formations, all as functions of both position and time. Nonsymmetrical boundary conditions were demonstrated to lead to bowing of the cylinder, and applicable techniques were developed to optimize the quenching process. Experiments for deriving physical and mechanical properties for the U-0.75 Ti alloy, including data on the heats of transformation were performed. The boundary heat-transfer coefficient is an important factor, affecting both the thermal and the metallurgical behavior during quenching.

36303 (Y/DV—524) Cleaning of aluminum alloy 5083. Koger, J.W. (comp.). (Oak Ridge Y-12 Plant, TN (USA)). 5 Jun 1986. Contract AC05-84OS21400. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012573.

The purpose of this investigation was to evaluate several different cleaning procedures on welds with very low heat inputs. The study evaluated the Oak Ridge Y-12 Plant's chemical cleaning, another type of chemical cleaning, ion cleaning, and diamond-machined cleaning. The results showed that the diamond-machining process provides better weld joint surfaces and sound welds with minimum oxide inclusion and porosity.

36304 (Y/DV—525) Diamond-machined aluminum alloy 5083 surfaces. Controlled exposure evaluation. Koger, J.W. (comp.). (Oak Ridge Y-12 Plant, TN (USA)). 5 Jun 1986. Contract AC05-84OS21400. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012572.

Electron spectroscopy for chemical analysis (ESCA) and scanning electron microscopy (SEM) were used to evaluate the effects of relative humidity of 0% to 85% RH and for time exposures of 1 to 100 d at room temperature on diamond-machined aluminum alloy 5083. The ESCA results showed that, in most cases, a limiting oxide thickness of ~12 A forms on the surface. Results showed that alloy to be slightly dependent on RH but independent of exposure time. The SEM examination revealed no observable difference in surface morphology when subjected to the controlled exposure parameters.

36305 (Y/DW—591) Application of secondary ion mass spectrometry to the study of a corrosion process: oxidation of uranium by water. Cristy, S.S.; Condon, J.B. (Oak Ridge Y-12 Plant, TN (USA)). 10 Sep 1985. Contract AC05-84OR21400. 7p. (CONF-8509197—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012091.

From 5. international conference on ion mass spectrometry; Washington, DC, USA (29 Sep 1985).

Corrosion of metals is an extremely important field with great economic and engineering implications at the Oak Ridge Y-12 Plant. To effectively combat corrosion, one must understand the processes occurring. This paper shows the utility of Secondary Ion Mass Spectrometry (SIMS) data for elucidating the processes occurring in one particular corrosion process - the oxidation of uranium by water - and for validating a theoretical model. It had long been known that the oxidation of uranium by water is retarded by the presence of oxygen gas and the retardation has been assumed to occur by site blocking at the surface. However, when alternate isotopic exposures were made, followed by exposure to a mixture of $^{16}O_2$ and $^{18}OH_2$, the rapid exchange of ^{16}O and ^{18}O occurred in the oxide layer, but the further oxidation by water in this and subsequent exposures was retarded for up to 21 hours. This shows graphically that OH_2 is not held up at the surface and that the retarding mechanism is effective at the oxide/metal interface rather than at the surface. The effectiveness of the O_2 to retard the further water oxidation was much reduced if no water-formed oxide layer were present. The effectiveness was also crystallite related. 12 refs., 5 figs.

36306 Formation of amorphous alloys by the mechanical alloying of crystalline powders of pure metals and powders of intermetallics. (Center for Materials Science, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Applied Physics Letters;* 49: No. 3, 146-148(21 Jul 1986).

Amorphous powders of $Ni_{33}Ti_{33}$ and of $Ni_{45}Nb_{55}$ were synthesized by mechanical alloying (MA) starting from either a mixture of pure metal powders (in the appropriate molar ratio) or from powders of the crystalline intermetallics $NiTi_2$ and $Ni_{45}Nb_{55}$, respectively. For both alloys, the peak temperature increase (above the average processing temperature)= in the powder particles trapped between colliding balls is estimated at 38 K. Thus, the amorphization is attributed to a process other than the formation of local melts followed by the rapid solidification of these melts into the amorphous phase. The amorphization by MA starting from a mixture of pure crystalline powders is attributed to a solid state interdiffusion reaction, the kinetics of which is controlled by the excess point and lattice defects generated by plastic deformation. The amorphization by MA starting from powders of crystalline intermetallics is attributed to the accumulation of point and lattice defects which raise the free energy of the faulted intermetallic above that of the amorphous alloy.

36307 Atomic resolution study of displacement cascades in ion-irradiated platinum. Pramanik, D.; Seidman, D.N. (Gould Semiconductors, Santa Clara, California 95051). *Journal of Applied Physics;* 60: No. 1, 137-150(1 Jul 1986). Contract AC02-76ER03158.

The field-ion microscope technique has been employed to study, on an atomic scale, the vacancy structure of individual depleted zones (DZs) in platinum specimens which had been created by 20-keV Kr^+ ions. DZs are the final quiescent state of collision cascades. The irradiations were performed in situ at 60 K and the specimens were examined at this temperature by the pulse field-evaporation technique. The following experimental quantities were determined for each DZ: (a) the absolute number of vacancies (ν); (b) the average diameter; (c) the average vacancy concentration based on ν and the actual volume filled by the vacancies; (d)= the radial distribution function of the vacancies out to the ninth nearest-neighbor; (e) the fraction of first-nearest-neighbor vacancies in clusters of size n; (f) the average depth (L) from the irradiated surface, measured along a direction parallel to the incident ion beam, at which each DZ was detected and its direction of elongation; and (g) the sputtering yield based on the number of vacancies detected in the near-surface region (<5 A thick). All of the measured quantities are compared with corresponding quantities extracted from either an analytical model or a Monte Carlo computer code (Transport of Ions in Matter: trIm) of radiation damage. We demonstrate that it is possible to transform a microscopic spatial distribution of vacancies to a continuous radiation damage profile with atomic resolution.

36308 Design of an ultralow coverage metal evaporator based on a geometric factor. (Stanford Electronics Laboratories, Stanford University, Stanford, California 94305). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 4, 1949-1951(Jul 1986).

An ultralow coverage eight-metal evaporator has been designed, built, tested, and put into use. Based on a geometric factor of 1:200, a metal coverage as low as 10^{-4} monolayer is reproducibly obtained with an error in coverage less than 20%. Various considerations during the design of the evaporator are discussed.

36309 Nb_3Sn(Ti) powder metallurgy processed high field superconductors. (Francis Bitter National Magnet Laboratory and Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Applied Physics Letters;* 48: No. 26, 1808-1810(30 Jun 1986).

Powder metallurgy processed Nb_3Sn(Ti) superconducting wires were fabricated with Sn x-italic wt. % Ti cores for 0< or =x-italic< or =3, 16 or 22 vol % cores, and a Cu 45 wt. % Nb composite. The processing used swaging, cold hydrostatic extrusions, wire drawing and heat treatments of 750 °C for two to four days. Nominal areal reductions of 10^4 were used. Hydride-dehydride Nb and rotating electrode processed Nb powders gave the

same performance. Overall critical current densities J-italic/sub c-italic/ were measured between 4.2 and 1.8 K for applied fields up to 23 T. J-italic/sub c-italic/ increased with increased Ti and/or Sn content. The Nb_3Sn(Ti) wires using a Sn 3 wt. % Ti, 22 vol % core gave J-italic/sub c-italic/ $>10^4$ A/cm^2 at 20 T and 4.2 K and J-italic/sub c-italic/ $= 10^4$ A/cm^2 at 23 T at 1.8 K. Removal of the precompression of the matrix increased J-italic/sub c-italic/ by about a factor of 2 at 20 T and 4.2 K.

38310 Optical absorption by clusters of small metallic spheres. Claro, F.; Fuchs, R. (Facultad de Fisica, Universidad Catolica de Chile, Casilla 6177, Santiago 22, Chile). *Physical Review [Section] B: Condensed Matter;* **33**: No. 12, 7956-7960(15 Jun 1986).

An ansatz for the distribution of depolarization factors, based on a theory of the optical response of nearly touching spheres, is used to calculate the optical absorption of a medium containing isolated clusters of small metallic spheres. The calculated absorption agrees qualitatively with experiments over the entire frequency range. In the far-infrared region we find enhanced absorption and predict a small deviation from an ω^2 frequency dependence.

38311 Embedded-atom-method functions for the fcc metals Cu, Ag, Au, Ni, Pd, Pt, and their alloys. Foiles, S.M.; Baskes, M.I.; Daw, M.S. (Sandia National Laboratories, Livermore, California 94550). *Physical Review [Section] B: Condensed Matter;* **33**: No. 12, 7983-7991(15 Jun 1986).

A consistent set of embedding functions and pair interactions for use with the embedded-atom method [M.S. Daw and M. I. Baskes, Phys. Rev. B 29, 6443 (1984)] have been determined empirically to describe the fcc metals Cu, Ag, Au, Ni, Pd, and Pt as well as alloys containing these metals. The functions are determined empirically by fitting to the sublimation energy, equilibrium lattice constant, elastic constants, and vacancy-formation energies of the pure metals and the heats of solution of the binary alloys. The validity of the functions is tested by computing a wide range of properties: the formation volume and migration energy of vacancies, the formation energy, formation volume, and migration energy of divacancies and self-interstitials, the surface energy and geometries of the low-index surfaces of the pure metals, and the segregation energy of substitutional impurities to (100) surfaces.

38312 Density-functional theory for random alloys: Total energy within the coherent-potential approximation. Johnson, D.D.; Nicholson, D.M.; Pinski, F.J.; Gyorffy, B.L.; Stocks, G.M. (Department of Physics, University of Cincinnati, Cincinnati, Ohio 45221). *Physical Review Letters;* **56**: No. 19, 2088-2091(12 May 1986). Contract AC05-84OR21400.

A density-functional—based theory is developed for calculation of the total energy and pressure of random substitutional alloys within the Korringa-Kohn-Rostoker coherent-potential approximation. The theory is used to calculate the concentration variation of the equilibrium lattice spacing of α-phase Cu/sub c/Zn/sub 1-c/ alloys. We find, in agreement with experiment, that the variation is almost linear and that it deviates from Vegard's rule.

38313 Ferromagnetism versus antiferromagnetism in face-centered-cubic iron. Pinski, F.J.; Staunton, J.; Gyorffy, B.L.; Johnson, D.D.; Stocks, G.M. (Department of Physics, University of Cincinnati, Cincinnati, Ohio 45221). *Physical Review Letters;* **56**: No. 19, 2096-2099(12 May 1986). Contract AC05-84OR21400.

Using a first-principles disordered-local-moment picture of itinerant-electron magnetism, we calculated the temperature and volume dependence of the magnetic moment and spin-spin correlations for fcc Fe in the paramagnetic state.

38314 Thermal impedance to normal and superconducting metals. (Department of Physics and Materials Research Laboratory, University of Illinois, Urbana, Illinois). *Journal of Low Temperature Physics;* **63**: No. 3, 269-286(1 May 1986). Contract AC02-76ER01198.

A simple model is presented of the thermal impedance encountered in the transfer of heat between a dielectric solid and a superconducting metal containing defects, defects which could be introduced by deformation. The model is consistent with new as well as published data, and in particular explains an anomalously large thermal impedance in superconducting aluminum near 0.1 K.

38315 Precipitation of icosahedral Al-Mn during pulsed laser melting. Aziz, M.J.; Budai, J.D. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Materials Research;* **1**: No. 3, 401-404(May 1986). Contract AC05-84OR21400.

The icosahedral phase has been produced by pulsed laser melting of thin films of Mn-implanted Al. With increasing laser intensity, we observe a mixture of icosahedral and fcc phases followed by a single phase fcc region. Grains as large as 1 μm in diameter have been observed in 0.1 μm thick films. Electron diffraction studies of individual icosahedral grains indicate that the rapid growth direction from the melt is along the threefold symmetry axis.

38316 Comparison of glow discharge cleaning and ion-impact desorption of stainless steel. Ruzic, D.N.; Gerdin, G.A.; Loxton, C.M. (Nuclear Engineering Program, University of Illinois, Urbana, Illinois 61801). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1232-1235(May 1986). Contract AC02-76ER01198.

The effects of glow discharge cleaning (GDC) and ion-impact desorption (IID) of impurities on 302 stainless steel were compared using Auger electron spectroscopy (AES). Hydrogen GDC was done in a chamber attached to the Auger microprobe allowing transfer in vacuo to lessen recontamination. GDC removed the surface hydrocarbon layer, but deposited many constituents of the cathode and surrounding areas onto the sample. It also induced a high concentration of carbon which extended beyond the surface layer. The extent of the carbon layer varied with the prior treatment of the surface. IID is shown to maintain a higher surface purity. The feasibility of helium IID as an after-opening or between-shot cleaning technique for magnetic fusion experiments is discussed.

38317 Experimental/theoretical comparison of spin-polarized low energy electron diffraction from the Cu(100) surface. Lind, D.M.; Jamison, K.D.; Dunning, F.B.; Walters, G.K.; Davis, H.L. (Departments of Physics and of Space Physics and Astronomy, Rice University, Houston, Texas 77251). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1271-1273(May 1986). Contract AC05-84OR21400.

A detailed theoretical/experimental spin-polarized low energy electron diffraction (SPLEED) investigation of Cu(100) is under way to explore the utility of SPLEED measurements in structure determinations for surfaces of low atomic number. Preliminary SPLEED calculations show that, in certain energy ranges, the results are very sensitive to the assumed structural model. Good agreement between theory and experiment is obtained using the surface model, which incorporates multilayer relaxation, that was derived from analysis of earlier LEED intensity data. Work is continuing to refine this model by use of SPLEED data.

38318 Recent developments concerning segregation and fracture at grain boundaries. White, C.L. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1633-1637(May 1986). Contract AC05-84OR21400.

Certain trace impurities have long been known to embrittle grain boundaries in polycrystalline metals and alloys. In recent years a large body of evidence, directly connecting impurity segregation to intergranular failure, has become available. Indeed, it was conventional wisdom for a time that all intergranular failure could be attributed to segregation of embrittling impurities, and that all segregation degrades grain boundary cohesion. There have been several interesting experimental and theoretical developments during the last 5—10 yr that run counter to this conventional wisdom, the study of which may significantly advance our understanding of the mechanism by which impurities affect grain boundary cohesion. Several examples of beneficial grain boundary segre-

gants will be presented, and the relationship between segregation behavior and grain boundary cohesion will be discussed.

38319 **Variable angle x-ray photoelectron spectroscopy and ion scattering spectroscopy study of the Ag/SiO_2 interface.** Pitts, J.R.; Thomas, T.M.; Czanderna, A.W. (Materials Branch, Solar Energy Research Institute, Golden, Colorado 80401). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1653-1657(May 1986). Contract AC02-83CH10093.

Thin Ag films of up to one monolayer on high purity fused silica have been investigated using variable angle x-ray photoelectron spectroscopy (XPS) and ion scattering spectroscopy (ISS). Silvered samples were prepared using the wet chemical process without reducers or by vacuum evaporation. After sensitization with a tin complex, it was determined from ISS that Sn is a surface species only and covers up to 30% of Si surface sites. Variable angle XPS verified these findings and suggested that the Sn is located above the Si surface plane. After silvering with the wet chemical process so that less than a monolayer of Ag is present on the surface, XPS showed that up to 60% of the surface Si is bound to Ag, while 20% of the surface Si sites remain covered by a Sn complex. ISS verified that Ag is a surface species and that 80% of the surface is covered by Ag and Sn. Variable angle XPS showed that Ag is raised out of the surface plane, and that it probably also resides over the Si. Analysis of one monolayer Ag films formed by vacuum evaporation on SiO_2 show similar results. Using XPS peak positions and Auger parameter shifts, evidence was found for Ag—Si bonding. Variable angle ISS gave strong evidence of Ag residing over the Si.

38320 **Field emission energy distribution study of laser-induced thermal effects.** Gao, Y.; Reifenberger, R. (Department of Physics, Purdue University, West Lafayette, Indiana 47907). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1289-1293(May 1986).

Laser-induced thermal effects on various surfaces of tungsten and molybdenum have been studied using field emitted electrons. Energy distributions measured by a dispersive electron energy analyzer allow the temperature increase of a laser-illuminated surface to be determined to within +-10 K. In addition to estimating the temperature rise, an analysis of the data also shows a sensitivity to small temperature-induced variations in the work function Phi. Fits to experimental data indicate that changes in Phi of a laser-illuminated surface can be estimated to within +-2 meV. The technique has been used to study W(100) surface reconstruction.

38321 **Island coalescence in a chemisorbed overlayer.** Pimbley, J.M.; Lu, T.H.; Wang, G.H. (Physics Department and Center for Integrated Electronics, Rensselaer Polytechnic Institute, Troy, New York 12181). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1357-1361(May 1986). Contract AC05-84OR21400.

We have constructed and solved an overlayer island growth model in which the distribution of the islands obeys an "extended geometric distribution function." This model describes quantitatively the growth of oxygen p(2 x 1) islands on a W(112) surface as the coverage is increased from 0 to 1. The average size of the islands is seen to increase sharply as the coverage approaches 1/2 monolayer, which is an indication of the coalescence of the overlayer islands.

38322 **Ion scattering spectroscopy and Auger electron spectroscopy depth profiles of silver—copper thin film interdiffusion.** Pitts, J.R.; Czanderna, A.W.; Thomas, T.M. (Materials Branch, Solar Energy Research Institute, Golden, Colorado 80401). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1671-1674(May 1986). Contract AC02-83CH10093.

Bilayers of Ag/Cu or Cu/Ag have been vacuum deposited in situ onto cleaned quartz, Si(100), and copper substrates at thicknesses from 20 to 50 nm, as measured with a quartz crystal oscillator. Depth profiles on the same samples were obtained using neon bombardment and either ion scattering spectroscopy (ISS) or Auger electron spectroscopy (AES) for compositional analysis. Profiles were taken after deposition at 30 °C and then after heating up to 300 °C, all in situ at about 20 nPa. Interdiffusion was detectable at 100 °C for both Ag/Cu and Cu/Ag bilayers, but differences were found in the extent of the diffusion. Dramatic differences were found in ISS and AES profiles of bilayers on silica and copper substrates. The differences are attributed to electron beam effects that result in profiles similar to those induced by thermal treatments at much higher temperatures. Reasons why the ISS profiles better represent the true in-depth composition are given.

38323 **Direct observations of surface chemical and structural changes resulting from the CO oxidation reaction on rhodium.** Kellogg, G.L. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1419-1423(May 1986). Contract AC04-76DP00789.

Surface modifications resulting from the CO oxidation reaction on Rh have been investigated by imaging atom-probe mass spectroscopy and field ion microscopy. Rhodium field emitter samples were heated to 500—600 K in 1—15 Torr of the reactant gases and transferred under UHV to the analysis chamber. Imaging atom-probe analysis was used to detect changes in surface composition, and field-ion microscope analysis was used to detect changes in surface morphology. For reaction temperatures of 500 K and total pressures between 1 and 2 Torr, the surface composition was found to change from primarily CO and surface carbon to Rh_2O_3 as the O_2/CO ratio was increased beyond 30/1. This ratio correlates with previous observations of the deactivation of the CO oxidation reaction providing direct evidence that the deactivation is oxide-induced. Field ion microscope images of Rh surfaces following the CO oxidation reaction in stoichiometric mixtures of CO and O_2 at total pressures from 1.5—15 Torr indicate morphological changes which differ from changes due to thermal annealing alone. The nature of the changes are in qualitative agreement with previous studies of ammonia oxidation and decomposition on macroscopic Pt spheres.

38324 **Loss of Ga in sputtered deposits made from a Pu-4 at. % Ga alloy.** Rizzo, H.F.; McClanahan, E.D.; Margolies, D.S.; Echeverria, A.W. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 518-523(May 1986). Contract W-7405-ENG-48.

Deposits of 5 to 500 μm thick coating were produced at rates from 0.025 to 2.5 μm/min on Al, Cu, Fe, and Kapton substrates in a triode system. Sputter parameters were as follows: Kr gas pressure (0.27—0.44 Pa), substrate temperature (21—184°C), target voltage (300—2000 V), substrate bias (-35 to -100 V), ion current density (60 to 120 A/m^2). A minimum substrate temperature of 100°C was necessary to fully stabilize the fcc structure in the deposits. Chemical analyses and energy dispersive spectroscopy indicated that deposits, under certain conditions, contained substantially less Ga than the target. The loss of Ga was controlled by increasing the substrate temperature above 180°C. The angular distribution of Pu and Ga sputtered under normal Kr^+ ion impingement on a flat polycrystalline target was also measured. The Pu distribution was found to be "under cosine" for 300 eV ions and "cosine" for 900 eV ions. The Ga atom distribution showed a wide variation at different angles (normal to the target) depending upon conditions. At 0° the ratio of Ga to Pu was higher than in the target.

38325 **Icosahedral-phase formation by solid-state interdiffusion.** Follstaedt, D.M.; Knapp, J.A. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physical Review Letters;* 56: No. 17, 1827-1830(28 Apr 1986). Contract AC04-76DP00789.

We have formed the icosahedral phase in $Al_{86}Mn_{14}$, $Al_{82}Mn_{18}$, and Al/sub 75.5/$Mn_{20}Si$/sub 4.5/ alloys by the interdiffusion of elemental layers in the solid state. Annealing at 250-425°C produced the phase in times as short as 1 min with grains up to ~14 nm in diameter. Continued annealing transformed the alloy layers into crystalline phases. These results demonstrate that the icosahedral phase nucleates in the solid state in preference to crystalline phases of lower free energy, even though the initial material does not have liquidlike icosahedral short-range order.

38326 Changes in the oxide scale formed on 304 stainless steel induced by additions of H_2S to CO-CO_2-N_2 gas environments. Prater, J.T.; Bradley, E.R.; Baer, D.R. (Pacific Northwest Lab., Richland, WA 99352). *Journal of the Electrochemical Society;* **133**: No. 4, 821(Apr 1986). Contract AC06-76RL01830.

The diffusion of sulfur through the oxide scale that formed on 304 stainless steel increased dramatically when initial scale growth occurred in the presence of small quantities of H_2S or H_2O. This behavior was related to differences in the scale microstructure. Scales formed at 950°C in H_2S-CO-CO_2-N_2 environments had much greater intergranular porosity than those produced in CO-CO_2-N_2 atmospheres. This porosity, which appeared to be the result of an enhanced growth of a filamentary noncompact (Mn, Fe)Cr_2O_4, compromised the scale as an effective barrier to sulfur penetration. X-ray photoelectron spectroscopy studies suggested that the dissociation of H_2S and subsequent recombination with oxygen introduced water vapor, and altered scale growth.

38327 (N—86-20544) Effect of volume fraction and size of fine-gamma prime particles on raising the creep strength of a DS nickel-base superalloy. Lin, D.L.; Yao, D.L.; Lin, X.J.; Sun, C.Q. Translated from Acta Metallurgica Sinica (Beijing, China), v. 18, no. 1, 104-114(Feb 1982) *Chin Shu Hsueh Pao ;* vp(Feb 1986). 23p. (NASA-TM—77983). NTIS, PC A02/MF A01.

The creep behavior of a directionally solidifiied nickel-base superalloy, DKS3, has been investigated as a function of the volume fraction and size of the gamma-prime phase at 760 and 950 C. The dislocation structure and morphology of gamma-prime was examined by transmission electron microscopy at the primary, secondary and tertiary creep stages at 73.8 kgf/sq mm. Experimental results are described in terms of a high temperature creep model in the range of temperatures and applied stresses where shearing of the gamma-prime phase does not control the straining process.

38328 Role of helium in the development of damage structure and swelling in neutron-irradiated aluminium. Farrell, K.; Chickering, R.W.; Mansur, L.K. (Oak Ridge National Lab., TN, USA). *Philosophical Magazine, [Part] A: Defects and Mechanical Properties;* **53**: No. 1, 1-26(Jan 1986). Contract AC05-84OR21400.

Helium and its state of agglomeration in pure aluminium prior to neutron irradiation are investigated with respect to its influence on the microstructural features developed during irradiation to doses of 0.005 to 2.6 d.p.a. at about 328 K (0.35 Tsub(m)). A level of 4 a.p.p.m. helium, in either submicroscopic form or as small bubbles at the resolvable limit of 2 nm diameter, induces large increases in both the cavity and dislocation components of the damage structure. It also causes swelling to begin much earlier in the neutron dose and to exhibit two different stages of evolution one early in the dose where the dose exponent of swelling is high, the other at later stages with lower exponent. When the helium is coarsened into 7-nm bubbles by annealing at 0.96 Tsub(m) before irradiation it has relatively small effects on damage structure and swelling. The increases in concentrations of cavities and dislocation loops in the presence of helium are attributed to trapping of radiation-produced vacancies by the helium, and a consequent retention of more interstitials in loops. Cavity nucleation data are shown to be consistent with a predicted critical cavity size of 1 to 2 nm diameter stabilized by helium. The swelling data are analysed by cavity-growth theory.

38329 Vacuum plasma spray turbine bucket coating development. Wood, J.H.; Schilke, P.W.; Collins, M.F. (General Electric Co., Schenectady, NY). *Archivio per le Scienze Mediche;* No. 85-GT-9, vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

Early gas turbines (1960s) manufactured by an American aerospace company used uncoated Udimet 500 as the principal first-stage bucket material. However, in connection with an increase in the gas turbine's firing temperature for imporved thermal efficiency, stronger alloys were required. The multiple requirements of alloy design, which include corrosion resistance and phase stability, have now made it essentially impossible to provide the desired levels of corrosion resistance and strength simultaneously. An approach for solving the resulting problem involves the employment of protective coatings. The present paper is concerned with a class of overlay coatings applied by vacuum plasma spray (VPS) techniques. These coatings have demonstrated improved hot-corrosion resistance compared to previously used coatings utilizing diffusion platinum aluminides. The first of the new coatings, involving a Co-CrAlY composition, has demonstrated more than 35,000 hours of life in field testing. 9 references.

38330 Oxidation resistance of gas turbine combustion materials. Rothman, M.F. (Cabot Corp., Kokomo, IN). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

The oxidation behavior of five different gas turbine combustor alloy materials has been characterized in both combustion burner rig environments and in flowing air. The alloys are compared in terms of resistance to weight loss, or thinning, and also in terms of resistance to subsurface internal attack. Burner rig exposures were performed at 1095 C (2000 F) for 100, 200 and 300 hours under combustion conditions involving an air to fuel ratio of about 50:1. Results are also presented for similar exposures where the burner rig air lines were unintentionally plugged-up, yielding a low air:fuel ratio and severe carbon deposition on the samples. In addition to the burner rig studies, results are presented for 1008 hour flowing-air oxidation exposures over the temperature range from 980 C (1800 F) to 1205 C (2200 F). 13 references.

38331 Directionally solidified DS CM 247 LC - Optimized mechanical properties resulting from extensive gamma prime solutioning. Erickson, G.L.; Harris, K.; Schwer, R.E. (Cannon-Muskegon Corp., Muskegon, MI). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

Complete coarse gamma prime and greater than 90 percent eutectic gamma-gamma prime solutioning, without incipient melting, is demonstrated for the DS CM 247 LC superalloy. This unusual capability for this advanced Ni-base turbine blade and vane material results in considerable mechanical properties enhancement, with the DS alloy capability being near to current single-crystal superalloys in the 345-207 MPa, 871-982 C operating condition. Microstructural features are detailed, correlating strength and alloys stability. 18 references.

38332 Fatigue-crack propagation behavior of Alloy A-286. James, L.A. (Westinghouse Hanford Company, Richland, Washington). pp 101-106 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-8. Fracture, fatigue and advanced mechanics. Short, W.E. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—). Contract AC06-76FF02170.

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

The effect of temperature upon the fatigue-crack propagation behavior of Alloy A-286 was studied at temperatures of 24, 316, 427, and 538°C. Two different heats representing two different product forms (strip and round bar) were employed. The effect of crack orientation was investigated for both product forms: T-L and L-T orientations in the strip and R-C and R-L orientations in the round bar. Specimens were irradiated to total neutron fluences of 7.5×10^{21} n/cm^2 and 5.2×10^{22} n/cm^2, and the effect of irradiation to these levels upon crack growth behavior was studied at 427°C.

38333 The fatigue-crack growth and ductile fracture toughness behavior of ASTM A387 grade 91 steel. James, L.A.; Carlson, K.W. (Westinghouse Hanford Co., Richland, Washington). pp 97-108 of Proceedings of the 1985 pressure vessels and piping conference. Volume PVP-98-1. Residual-life assessment, nondestructive examination, and nuclear heat exchanger materials. Jaske, C.E. New York, NY; American Society of Mechanical Engineers (1985). (CONF-850670—). Contract AC06-76FF02170.

From ASME Pressure Vessel and Piping Division conference; New Orleans, LA, USA (24 Jun 1985).

Fatigue-crack growth tests were conducted on three heats of wrought material plus one heat of weldment at temperatures of 24, 316, 427, 538, and 593°C. The effects of heat-to-heat variations, crack orientation, and thermal aging were studied. In addition, stress ratio effects were characterized at 427°C. The J-integral technique was used to determine the ductile fracture toughness at room temperatue. Both the multiple specimen and unloading compliance techniques were used, and differences between the two methods are discussed.

38334 Direct solid metal analysis by laser ablation into the inductively coupled plasma. Cremers, D.A.; Archuleta, F.L. (Chem. Div., Univ. of California, Los Alamos National Lab., Los Alamos, NM 87545). pp 542-546 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

Elemental analysis of solids using the inductively coupled plasma (ICP) often involves the time-consuming step of reducing the solid to a solution that is nebulized into the plasma. Most of the sample preparation step can be eliminated by introducing the solid directly into the ICP using a laser ablation technique. This report describes the main results of a study of laser ablation using an acousto-optically Q-switched Nd:YAG laser. The laser pulses (5 kHz rep. rate) were focused on a solid metal surface to generate a metal aerosol which was entrained in a flowing gas stream, transported through a tube, and then introduced directly into the ICP. Some characteristics of laser ablation for solid steel analysis are reported along with calibration curves and the accuracy and precision of the method for several elements.

38335 FIM/IAP/TEM studies of ion implanted nickel emitters. Walck, S.D.; Hren, J.J. (Univ. of Florida, Gainesville). *Materials Research Society Symposia Proceedings;* **41**: 325-330(1985). Contract AS05-83ER45039.

Accurate depth profiling of implanted hydrogen and its isotopes in metals is extremely important. Field ion microscopy and atom-probe techniques provide the most accurate depth profiling analytical method of any available. In addition, they are extremely sensitive to hydrogen. This paper reports our early work on hydrogen trapping at defects in metals using the Field Ion Microscope/Imaging Atom Probe (FIM/IAP). Our results deal primarily with the control experiments required to overcome instrumental difficulties associated with in situ implantation and the influence of a high electric field. Transmission Electron Microscopy (TEM) has been used extensively to independently examine the influence of high electric fields on emitters. 11 references, 7 figures.

38336 Study of hydroxyl formation on Pt(111) surface by EELS and low temperature reaction quenching. Melo, A.V.; O'Grady, W.E.; Chottiner, G.S.; Hoffman, R.W. (Brookhaven National Lab., Upton, NY). *Applications of Surface Science;* **21**: 160-167(1985). Contract AC02-76CH00016.

The thermal evolution of the hydroxyl species formed from the reaction of adsorbed oxygen and water on a Pt(111) surface have been studied using high resolution electron energy loss spectroscopy (HREELS) in combination with low temperature reaction quenching. At low oxygen coverages (0 much less than 0.25), it was found that an exposure of 0.3 L of H_2O resulted in the spontaneous formation of hydroxyl species. At high H_2O exposures, coupled with careful thermal annealing, it has been possible to observe the intermediate states in the evolution of the hydroxyl species. The appearance of a strong 660 cm^{-1} band indicates strong hydrogen bonding of the H_2O molecule to the adsorbed oxygen. Further heating leads to the rupture of the water molecule bond and the formation of the hydroxyl species. 9 references, 3 figures.

38337 VUV synchrotron light as a technique for studying the interface quality and properties of thin overlayers. Ruckman, M.W.; Murgai, V.; Strongin, M. (Brookhaven National Lab., Upton, NY). *Materials Research Society Symposia Proceedings;* **41**: 349-354(1985). Contract AC02-76CH00016.

The measurements presented here show the value of synchrotron light for determining both the electronic structure of overlayers, and the physical nature of the overlayer-substrate interface. A comparison is given between deposited layers and thermally stabilized layers. Estimates are also made of the bonding energy between the overlayer and substrate. 8 references, 8 figures.

38338 Ab initio calculations on large Be clusters. Ermler, W.C.; Kern, C.W.; Pitzer, P.M.; Winter, N.W. (Stevens Institute of Technology, Hoboken, NJ). pp 116 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

Closed and open shell self-consistent field calculations are reported for clusters of 13, 19, 21, 33, and 39 Be atoms. Geometrical arrangements correspond to the second through sixth coordination spheres of a central Be atom with internuclear separations all derived from the lattice constants of the bulk metal (a=2.2866 A, c=3.5833 A). Each cluster possesses D/sub 3h/ point group symmetry. Nineteen electronic states of Be_{13} and six states of Be_{13}^+ are discussed. Electric field gradients, nuclear electron potentials, second moments, and orbital energy diagrams are given for each cluster. The convergence of properties having origin at the central Be atom as a function of cluster size is slow and is not yet achieved with the inclusion of the sixth coordination sphere.

38339 Microstructure of rapidly quenched type 308 stainless steel weld filler metal and its implications on rapid solidification processes. David, S.A.; Vitek, J.M. (Oak Ridge National Lab., TN). pp 847-850 of Rapidly quenched metals. Steeb, S.; Warlimont, H. (eds.). Amsterdam, Netherlands; Elsevier Science Publishers B.V. (1985). Contract AC05-84OR21400.

From 5. international conference on rapidly quenched metals; Wuerzburg, Germany, F.R. (3-7 Sep 1984).

The structure of type 308 stainless steel was evaluated following rapid quenching using the hammer-arc process. A large degree of variation was found from a fully austenitic structure to the duplex ferrite plus austenite structure commonly found in welded material. The lack of large-scale segregation, as determined by electron microprobe analysis, indicates the structural variations are due to cooling rate changes rather than compositional fluctuations. The results also show that this material is very sensitive to cooling rate in the range prevalent in the hammer-arc process. 4 references, 2 figures.

38340 Wear behavior of nitrogen-implanted metals. Oliver, W.C.; Hutchings, R.; Pethica, J.B. (Oak Ridge National Lab., TN). *Metallurgical Transactions,* [*Section*] *A: Physical Metallurgy and Materials Science;* **15A**: 2221-2229(Dec 1984).

The effect of nitrogen implantation on the wear behavior of a range of metals have been studied. Harness measurements and pin-on-disc wear tests which characterize specifically the properties of the thin implanted layer have been carried out. It is shown that large improvements in wear resistance can be obtained by nitrogen implantation and that a loose correlation exists between reduced wear and increased surface hardness. However, it is demonstrated, on the basis of detailed examination of the wear tracks, that the best improvements in wear performance occur only when implantation produces a change in the dominant mode of wear. It is further shown that the formation of surface oxide layers during the wear process is often associated with these changes in wear behavior. The wear mechanisms, and the changes thereof, are described and discussed in detail for Ti-6Al-4V, hard chromium electroplate, and a range of ferrous alloys. 24 references, 12 figures, 3 tables.

38341 Grinding/polishing tool to aid thin section preparation of small samples. Naney, M.T. (Oak Ridge National Lab., TN). *American Mineralogist;* **69**: 404-405(Mar-Apr 1984). Contract W-7405-ENG-26.

A simple two piece grinding/polishing tool permits controlled thinning of samples mounted on round petrographic glass slides. The tool consists of a body with a finely-threaded axial hole

and an adjusting screw to control sample thickness. 2 references, 1 figure.

38342 Use of electrodeposited silver as an aid in diffusion welding. Dini, J.W.; Kelley, W.K.; Cowden, W.C.; Lopez, E.M. (Lawrence Livermore National Lab., CA). *Welding Research Supplement;* 26-34(Jan 1984). Contract W-7405-ENG-48.

Sound, high strength diffusion welded joints were obtained with silver plated stainless steel, beryllium and uranium. The procedures used for preparing the substrates for plating were first characterized by using ring shear tests, which provided quantitative information on weld adhesion. For the joining studies, a full factorial experiment with two levels and four variables (2^4) was run with stainless steel. Fewer experiments were run with beryllium and uranium. Best joints were obtained with welding conditions which included 1 hour at a temperature of 600°C (1112°F), pressure of 30,000 psi (207 MPa) and plating thickness of 1 mil (0.001 in.) of silver. 14 references, 13 figures, 8 tables.

38343 Niobium in high temperature applications. Inouye, H. (Metals and Ceramics Div., Oak Ridge National Lab., P.O. Box X, Oak Ridge, TN 37830). pp 615 of Niobium - Proceedings of the international symposium. Stuart, H. Warrendale, PA; Metallurgical Society of AIME (1984). (CONF-8111237—).

From Niobium international symposium; San Francisco, CA, USA (8 Nov 1981).

A critical review of the literature shows that niobium alloys have potential aerospace applications to 1316°C (2400°F) in closed cycle power systems in the uncoated state or for glide re-entry vehicles and rocket nozzles in the coated state. The survey shows that technical feasibility depends principally on controlling the oxidation and/or coating-substrate reactions as they severely degrade alloy mechanical properties. Data are presented to illustrate these instabilities and the technology developed is summarized to show how the incompatibility problems were or could be resolved.

38344 Effects of nonperiodic void spacing upon intergranular creep cavitation. Fariborz, S.J.; Harlow, D.G.; Delph, T.J. (Lehigh Univ., Bethlehem, PA). *Acta Metallurgica;* vp(1984). Contract FG02-84ER45088.

The effects of nonperiodic void spacing upon creep rupture by intergranular cavitation is investigated. This is done by carrying out a Monte Carlo simulation of a 1-D model consisting of long, cylindrical voids having a uniform random spatial distribution along the grain boundary of a bicrystal. It is found that a progressive sintering and void coalescence process leads to times-to-failure which on the average are an order of magnitude greater than that predicted in the case where the voids are taken to be periodically spaced. Also predicted is a slightly greater dependence on times-to-failure with applied remote stress than that predicted in the equispaced case. Of particular note is the scatter in the predicted times-to-failure at constant remote stress, which is found to be well-described by a Weibull cumulative distribution function. 21 references, 5 figures.

38345 Effect of interatomic potential on the calculated energy and structure of high-angle coincident site grain boundaries. I. (100) twist boundaries in aluminum. Wolf, D. (Argonne National Lab., IL). *Acta Metallurgica;* 32: No. 2, 245-258(1984).

A new computer code is described which permits the investigation of the energy and structure of coincident-site lattice (CSL) grain boundaries in metals. As an improvement over computer programs used by other workers, the full second-derivative (force-constant) matrix associated with a given interatomic potential is applied for the iterative energy minimization. Using this extremely efficient and reliable procedure the effect of the form of the interatomic potential and its truncation radius on the predicted grain-boundary energy and structure is investigated. Six different potentials for aluminum, ranging from a Morse potential to a pseudopotential, are applied to the simulation of the energy and structure (100) CSL twist boundaries with values of Σ, the inverse density of CSL sites, ranging between $\Sigma = 5$ and $\Sigma = 73$. It is found that not only do both the energy and structure of a given boundary vary greatly from one potential to another, but also that the relative energies of different boundaries, i.e. the boundary-energy vs misfit-angle curves, depend on the potential. In contrast to recent claims of Brokman and Balluffi, no cusps in these curves are found for potentials which ignore the charge-density oscillations. The two basic assumptions of the Brokman-Balluffi cusp model are found to be valid only for extremely simple potentials with very short cutoff radii. It is suggested that (1) charge-density oscillations may be important for predicting grain-boundary properties, and (2) no obvious relationship exists between grain-boundary geometry (Σ) and the energy. 39 references, 18 figures, 1 table.

38346 Application of the finite method in micromechanical analyses of creep fracture problems. Lau, C.W.; Argon, A.S.; McClintock, F.A. (Massachusetts Institute of Technology, Cambridge). *Computers and Structures;* 17: No. 5-6, 923-931(1983). Contract AC02-77ER04461.

The finite element method is applied to determine the generalized stress intensity factors for two problems fundamental in the micromechanical study of intergranular creep fracture. Special techniques to simulate multipoint constraints arising from symmetry and periodicity, and a singularity element have been developed and proved effective. The good agreements of finite element results with local field solutions are discussed. 19 references, 12 figures.

38347 Magnetic property changes in epitaxial metal film sandwiches. Brodsky, M.B. (Argonne National Lab., IL). *Journal of Magnetism and Magnetic Materials;* 35: 99-104(1983).

Epitaxial metal film sandwiches (EMFS) containing Pd or Cr, have been prepared between single crystal Ag or Au. The Modified Pd/Cr show major changes in physical properties. Pd has a stretched lattice parameter in Au-Pd-Au, which combines with a tetragonal distortion to cause exchange enhancements up to 28,000 and spin fluctuation temperatures of 1-10 K. In Au-Cr-Au, Cr takes up the fcc structure, leading to superconductivity due to a high N(E/sub F). These results are contrasted to data for Ag-Pd-Ag and Ag-Cr-Ag EMFS. 30 references, 6 figures, 2 tables.

38348 Crystal growth and controlled doping of epitaxial Ge Films on (100)GaAs by sputter deposition. Cadlen, K.C.; Greene, J.E. (Univ. of Illinois, Urbana). *Journal of Crystal Growth;* 61: 15-22(1983). Contract AC02-76ER01198.

Heteroepitaxial Ge films have been grown on (100)GaAs substrates by RF sputter deposition. A new technique for controlled doping during sputtering was used to obtain In-doped p-type films with room temperature hole concentrations between 5×10^{16} and 5×10^{18} cm^{-3}. The films exhibited hole mobilities to the best reported values for Ge films on GaAs grown by other techniques. Moreover, films grown at temperatures $\geq$ 500°C with thicknesses $\geq$ 2.5 μm had mobilities comparable to those obtained in bulk samples with similar doping concentrations. 20 references, 8 figures.

38349 Photoemission spectroscopy of surfaces and adsorbates. Chiang, T.C.; Kaindl, G.; Himpsel, F.J.; Eastman, D.E. (Univ. of Illinois at Urbana-Champaign, Urbana). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 759-771(1982). (CONF-820855—). Contract AC02-76ER01198.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

Core level photoelectron spectroscopy is providing new information concerning the electronic properties of adsorbates and surfaces. Several examples will be discussed, including studies of adsorbed rare gas submonolayers and multilayers as well as clean metal surfaces. For rare gas multilayers adsorbed on metal surfaces, the photoelectrons and Auger electrons exhibit well-resolved increases in kinetic energy with decreasing distance between the excited atom and the substrate, allowing a direct labeling of the layers. These energy shifts are mainly due to the substrate screening effects, and can be described well by an image-charge model. For a Kr/Xe bilayer system prepared by first coating a Pd substrate with a monolayer of Kr and then overcoating with a layer of Xe, a thermally activated layer inversion process is observed when

the temperature is raised, with Xe coming in direct contact with the substrate. For rare gas submonolayers adsorbed on the Al(111) surface, coverage-dependent core level shift and work function measurements provide information about the adatom spatial distributions, polarizabilities, and dipole moments for the ground and excited states. The 2p core level shifts for a clean Al(001) surface relative to the bulk have also been studied. The shifts have a large contribution from the initial-state effects. 20 references, 7 figures, 2 tables.

38350 (CE-Trans—8177) Some properties of simulated heat-affected zones in Cr-Mo-V cast steel. Asakura, S.; Nihei, M. Translated from *Yosetsu Gakkaishi ;* **49**: No. 2, 143-148(1980). 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86901280.

The notch ductility of the welding heat-affected zone (HAZ) in low alloy steels like the Cr-Mo-V cast steel under test is sensitive to microstructural change in the course of cooling, and although the effect varies with the species and amount of alloying elements added, marked embrittlement occurs owing to increase in the amount of bainite if the preheating temperature used to prevent cracking is too high. Apart from cooling rate, the factors affecting notch ductility include the maximum heating temperature in the welding heat cycle, the various peak temperatures in a multiple heat cycle, the inter-pass temperature, and post-heating conditions, the effects of which vary with the cooling time in the heat cycle. To clarify the relation between the above factors for the base metal under test, we constructed a continuous cooling transformation diagram (SH-CCT diagram) and examined the effect of various welding heat cycles and post-heating conditions on impact strength, hardness and microstructure by means of heat cycle simulation tests. In addition, the relation between notch ductility and cooling rate was investigated for actual and simulated heat-affected zones.

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REFER ALSO TO CITATION(S) 38241, 38447, 39382, 39405

38351 (CONF-860829—21) Recrystallization behavior of ion beam modified α-Al_2O_3. Sklad, P.S. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009353.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Transmission electron microscopy was used to study amorphized implanted α-Al_2O_3. The response of the as-implanted amorphous layer to thermal aging varied with annealing tmperature and time. The recrystallization is total and epitaxial at 1190°C. (DLC)

38352 (CONF-860854—2) Microanalysis by electron energy loss spectroscopy at 300kV. Bentley, J.; Angelini, P. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 3p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009306.

From 11. international congress on electron microscopy; Kyoto, Japan (31 Aug 1986).

Some features of the anticipated improvements in microanalysis by electron energy loss spectroscopy (EELS) at 300 kV compared to opeation at 100kV have been studied with the use of a Philips EM430T equipped with Gatan 607 EELS and EDAX 9100/70 systems. Detailed measurements have been made on a range of specimens, with emphasis on boron nitride and silicon carbide.

38353 (LA-UR—86-2130) Plasma synthesis and characterization of ultrafine SiC. Vogt, G.J.; Phillips, D.S.; Taylor, T.N. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 27p. (CONF-860883—1). NTIS, PC A03/MF A01; GPO Dep. File Number DE86012403.

From Ceramic powder science and technology; Boston, MA, USA (3 Aug 1986).

Ultrafine SiC powders have been prepared by gas phase synthesis from silane and methane in an argon thermal rf-plasma. Bulk properties of the powders were determined by elemental analysis, x-ray diffractin, helium pycnometry, and BET surface area measurements. The near-surface composition and structure of the particles were examined by x-ray photoelectron spectroscopy (XPS) and transmission electron microscopy (TEM). In addition to free silicon and carbon particles in the powders, free carbon and various silicon/carbon/oxygen species were found on the surface of the SiC particles.

38354 (N—86-20497) Rocket thrust chamber thermal barrier coatings. Final Report, December 1981-October 1984. Batakis, A.P.; Vogan, J.W. (Solar Turbines International, San Diego, CA (USA)). Jul 1985. 169p. (NASA-CR—175022). NTIS, PC A08/MF A01.

A research program was conducted to generate data and develop analytical techniques to predict the performance and reliability of ceramic thermal barrier coatings in high heat flux environments. A finite element model was used to analyze the thermomechanical behavior of coating systems in rocket thrust chambers. Candidate coating systems (using a copper substrate, NiCrAlY bond coat and $ZrO_2.8Y_2O_3$ ceramic overcoat) were selected for detailed study based on photomicrographic evaluations of experimental test specimens. The effects of plasma spray application parameters on the material properties of these coatings were measured and the effects on coating performance evaluated using the finite element model. Coating design curves which define acceptable operating envelopes for seleted coating systems were constructed based on temperature and strain limitations. Spray gun power levels was found to have the most significant effect on coating structure. Three coating systems were selected for study using different power levels. Thermal conductivity, strain tolerance, density, and residual stress were measured for these coatings. Analyses indicated that extremely thin coatings (0.02 mm) are required to accommodate the high heat flux of a rocket thrust chamber and ensure structural integrity.

38355 (N—86-22451) Transformation toughened ceramics for the heavy duty diesel engine technology program, phase 2. Final Report, August 1984-July 1985. Musikant, S.; Samanta, S.C.; Architetto, P.; Feingold, E. (General Electric Co., Philadelphia, PA (USA)). Dec 1985. 86p. (NASA-CR—175054). NTIS, PC A05/MF A01.

The objective of this program is to develop an insulating structural ceramic for application in a heavy duty adiabatic diesel engine. The approach is to employ transformation toughening (TT) by additions of zirconia-hafnia solid solution (ZHSS). The feasibility of using ZHSS as a toughening agent in mullite and alumina has been demonstrated in Phase 1 of this work. Based on Phase 1 results, a decision was made to concentrate the Phase 2 effort on process optimization of the TT mullite. A strong factor in that decision was the low thermal conductivity and high thermal shock resistance of the mullite. Results of the Phase 2 effort indicate that optimum toughening of mullite by additions of ZHSS is difficult to achieve due to apparent sensitivity to morphology. The 48 ksi room temperature modulus-of-rupture (MOR) achieved in selected specimens is approximately 50% of the original strength target. The MOR deteriorated to 34 ksi at 800 C.

38356 (PNL-SA—13907) Fracture toughness in nuclear waste glasses and ceramics: environmental and radiation effects. Weber, W.J.; Matzke, H.J. (Pacific Northwest Labs., Richland, WA (USA); Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements). Mar 1986. Contract AC06-76RL01830. 15p. (CONF-8511146—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011613.

From Conference on indentation fracture and mechanical properties of ceramic fuels, waste ceramics and glasses; Karlsruhe, F.R. Germany (11 Nov 1985).

The effects of atmospheric moisture and radiation damage on fracture properties of nuclear waste glasses and ceramics was investigated by indentation techniques. In nuclear waste glasses, atmospheric moisture has no measurable effect on hardness but decreases the fracture toughness; radiation damage, on the other hand, decreased the hardness and increased the fracture toughness. In nuclear ceramics, self-radiation damage from alpha decay decreased the hardness and elastic modules; the fracture toughness increased with

dose to a broad maximum and then decreased slightly with further increases in dose.

36357 Growth of periodic structures in pyrolytic laser-deposited SiC. Shaapur, F.; Allen, S.D. (Center for Laser Studies, University of Southern California, Los Angeles, California 90089-1112). *Journal of Applied Physics;* **60**: No. 1, 470-472(1 Jul 1986).

Nonmelting surface interference ripples have been conclusively observed for the first time in thermally driven deposition of SiC from SiH_4 and CH_4. One set of ripples with a spatial frequency close to the primary beam wavelength (9.27 μm) is formed normal to the E field of the incident beam. An additional set of small-amplitude ripples of 1 μm or less in spacing and oriented parallel to the E field is also observed. These structural features are more pronounced in samples with higher melting points and completely disappear as the irradiated surface melts.

36358 Glass ceramic toughened with tetragonal zirconia. Keefer, K.D.; Michalske, T.A. (to Dept. of Energy, Washington, DC). US Patent 4,587,224. 6 May 1986. Filed date 10 Feb 1984. vp.

A glass-ceramic composition is described consisting of, in its original melt and on a weight basis, about 57 parts SiO_2, about 21 parts ZrO_2, about 5 parts Li_2O, and about 17 part B_2O_3; wherein the ZrO_2 in the finished glass-ceramic is present in metastable tetragonal form.

36359 Selective radiative cooling with MGO and/or LIF layers. Berdahl, P.H. (to Dept. of Energy, Washington, DC). US Patent 4,586,350. 6 May 1986. Filed date 14 Sep 1984. vp.

A selective radiative cooling material is described consisting of: an infrared-reflective substrate, and at least one layer of material selected from the group consisting of ceramic magnesium oxide, polycrystalline lithium fluoride, and mixtures thereof.

36360 Microstructure evolution in TiN films reactively sputter deposited on multiphase substrates. Helmersson, U.; Sundgren, J.; Greene, J.E. (Thin Film Group, Department of Physics and Measurement Technology, Linkoeping University, S-581 83 Linkoeping, Sweden). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 500-503(May 1986). Contract AC02-76ER01198.

Cross-sectional transmission electron microscopy (X-TEM) has been used to investigate the microstructure of TiN films deposited by reactive magnetron sputtering onto ASP 30 high speed steel (HSS) substrates. ASP 30 is a multiphase material consisting of a martensitic matrix with MC and M_6C transition—metal particles embedded in it. The TiN films were ~4 μm thick and were grown at substrate temperatures T/sub s/ between 200 and 550°C. The X-TEM results showed that the film microstructure was very nonhomogeneous. A dense columnar morphology was observed above both the martensitic and M_6C substrate phases. The average column diameter <d> ranged from 15 nm (T/sub s/ = 200°C) to 50 nm (T/sub s/ = 550°C) near the film/substrate interface over the martensitic phase and was in a factor of 2 less in the film regions adjacent to the M_6C phase. <d> increased in both regions to 100 nm (T/sub s/ = 200°C) to 150 nm (T/sub s/ = 550°C) near the surface of the films. TiN grew epitaxially on MC particles but contained a high dislocation density which (except at 550°C where some of the epitaxial grains extended throughout the entire film thickness) eventually coalesced to form low-angle grain boundaries and, finally, high-angle boundaries.

36361 Method for preparing PB-β″-alumina ceramic. Hellstrom, E.E. (to Dept. of Energy, Washington, DC). US Patent 4,585,635. 29 Apr 1986. Filed date 30 Aug 1984. vp.

A method is described for substituting cations for Na ions in a formed polycrystalline structure body of Na-β″-alumina, Na-β″-ferrite, or Na-β″-gallate consisting essentially of trivalent cation and O lattice and of Na ions which migrate in relation to the trivalent cation and O lattice of the structure under the influence of an electric field. The method consists of heating the body, contacting the body with a vapor source of K, Rb, or Cs ions heated to a temperature essentially equal to the temperature of the body, maintaining the body and the source of ions at the temperature, the temperature being sufficient to cause at least about 90% of the Na ions in the body to be replaced by the vapor source ions, immersing the resultant body in a molten salt having divalent and trivalent cations larger than Na ions and no greater than the vapor source ions, and maintaining the body immersed in the molten salt until about 90% of the vapor source ions are replaced by the divalent or trivalent cations, whereby a substituted formed polycrystalline body substantially free of cracks is obtained.

36362 Chemical vapor deposition of boron-based refractory solids. Mullendore, A.W. (Sandia National Laboratories, Albuquerque, NM 87185). *AIP (American Institute of Physics) Conference Proceedings;* **140**: No. 1, 41-50(15 Apr 1986). (CONF-850786—). Contract AC04-76DP00789.

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

Boron and the high-borides being considered for use as high temperature semiconductors can, in general, be prepared by chemical vapor deposition (CVD). The process can yield high density, high purity deposits of controlled stoichiometry at temperatures of deposition which are moderate relative to the melting points of the materials. A further advantage of CVD is its potential for single crystal growth either by crystallographically preferred directional growth (needles or platelets) or by heteroepitaxial growth on single crystal substrates.

36363 Rhombohedral crystal structure of compounds containing boron-rich icosahedra. Morosin, B.; Mullendore, A.W.; Emin, D.; Slack, G.A. (Sandia National Laboratories, Albuquerque, NM 87185). *AIP (American Institute of Physics) Conference Proceedings;* **140**: No. 1, 70-86(15 Apr 1986). (CONF-850786—).

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

The crystal structures of several icosahedral boron containing compounds have been refined using Mo Kα intensity data. Though these compounds, α-boron, boron carbide, boron phosphide and boron arsenide, differ chemically, all have the same basic rhombohedral structure. The structures consist of icosahedral units bonded together with direct B-B bonds as well as other linkage units. Similarities in electron distributions are found with respect to the icosahedra in all the compounds; differences are associated with the linkage units. The icosahedral bond distances show trends as one progresses along the series with increasing linkage units.

36364 High resolution imaging of boron carbide microstructures. MacKinnon, I.D.R.; Aselage, T.; Van Deusen, S.B. (Department of Geology, University of New Mexico, Albuquerque, NM 87131). *AIP (American Institute of Physics) Conference Proceedings;* **140**: No. 1, 114-120(15 Apr 1986). (CONF-850786—). Contract AC04-76DP00789.

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

Two samples of boron carbide have been examined using high resolution transmission electron microscopy (HRTEM). A hot-pressed $B_{13}C_2$ sample shows a high density of variable width twins normal to (10*1). Subtle shifts or offsets of lattice fringes along the twin plane and normal to ~(10*5) were also observed. A B_4C powder showed little evidence of stacking disorder in crystalline regions.

36365 Auger electron spectroscopy studies of boron carbide. Madden, H.H.; Nelson, G.C.; Wallace, W.O. (Sandia National Laboratories, Albuquerque, NM 87185). *AIP (American Institute of Physics) Conference Proceedings;* **140**: No. 1, 121-129(15 Apr 1986). (CONF-850786—). Contract AC04-76DP00789.

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

Auger electron spectroscopy has been used to probe the electronic structure of ion bombardment (IB) cleaned surfaces of

B_9C and B_4C samples. The shapes of the B-KVV and C-KVV Auger lines were found to be relatively insensitive to the bulk stoichiometry of the samples. This indicates that the local chemical environments surrounding B and C atoms, respectively, on the surfaces of the IB cleaned samples do not change appreciably in going from B_9C to B_4C. Fracturing the sample in situ is a way of producing a clean representative internal surface to compare with the IB surfaces. Microbeam techniques have been used to study a fracture surface of the B_9C material with greater spatial resolution than in our studies of IB surfaces. The B_9C fracture surface was not homogeneous and contained both C-rich and B-rich regions. The C-KVV line for the C-rich regions was graphitic in shape. Much of the C-rich regions was found by IB to be less than 100 nm in thickness. The C-KVV line from the B-rich regions was carbidic and did not differ appreciably in shape from those recorded for the IB cleaned surfaces.

38366 Electronic transport in boron carbides. Emin, D. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *AIP (American Institute of Physics) Conference Proceedings;* **140**: No. 1, 189-205(15 Apr 1986). (CONF-850786—). Contract AC04-76DP00789.

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

The electronic transport of boron carbides, B/sub 1-x/C/sub x/ with 0.1< or =x< or =0.2, between 300K and 1200 K is inconsistent with conventional models of both itinerant and hopping transport. While the thermally activated conductivities and the low weakly activated Hall mobilities suggest the hopping of a high density ($\sim 10^{21}$ cm^{-3}) of small polarons, the spin densities are orders of magnitude smaller than this. Furthermore, the p-type Seebeck coefficients are both large (>100 $\mu V/K$) and strongly increasing functions of temperature, rather than being small and weakly temperature dependent as expected of degenerate semiconductors. Finally, unlike "standard" hopping systems, the electrical conductivity decreases with applied pressure. This is due to a pressure dependent increase of the conductivity activation energy. The anomalous thermoelectric, magnetic, and pressure-dependent transport properties are attributed to the charge carriers being hole-like small singlet bipolarons which hop between inequivalent $B_{11}C$ icosahedra.

38367 Polaron formation in systems of boron icosahedra. Howard, I.A.; Beckel, C.L.; Emin, D. (Department of Physics and Astronomy, University of New Mexico, Albuquerque, New Mexico 87131). *AIP (American Institute of Physics) Conference Proceedings;* **140**: No. 1, 240-248(15 Apr 1986). (CONF-850786—). Contract AC04-76DP00789.

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

It has been proposed that electrical transport in boron carbides is accomplished by hopping of singlet electron pairs between bipolaronic states localized on the icosahedra. Formation of a bipolaron will be accompanied by a distortion of the associated icosahedron. We have used quantum-chemical calculational techniques to consider the relation between charge state and distortion for a system consisting of a B_{13} icosahedron and 12 tieoff atoms. It is found that localization of two extra electrons on an icosahedron results in a contraction of the icosahedral cage and a reduction of the total energy of the cluster by ~1.3 eV compared to that of the neutral cluster. The reduction in energy corresponds to the formation energy of a bipolaron in our model. Extensions of the model planned include calculations of polaron vs. bipolaron formation energies.

38368 Electronic structure of boron-rich borides. Switendick, A.C. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *AIP (American Institute of Physics) Conference Proceedings;* **140**: No. 1, 260-273(15 Apr 1986). (CONF-850786—). Contract AC04-76DP00789.

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

I have calculated the electronic energy band structures of cubic YB_{12} and $B_{12}P_2$ and related boron-like structures. The origin of semiconducting behavior for 3n+2 electrons is confirmed. Without the anion, the structure is closely related to α rhombohedral boron. Densities of states and the character of the bonding will be displayed.

38369 Magnetic susceptibility of boron carbides. Azevedo, L.J.; Venturini, E.L.; Emin, D.; Wood, C. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *AIP (American Institute of Physics) Conference Proceedings;* **140**: No. 1, 288-291(15 Apr 1986). (CONF-850786—). Contract AC04-76DP00789.

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

We have measured the magnetic susceptibility of four compositions of boron carbides, B/sub x/C including x = 4, 6.5, 7.5 and 9. After analysis and corrections for small ferromagnetic impurities and diamagnetic contributions to the susceptibility we find that the spin concentration for all the samples is two orders of magnitude smaller than that determined by transport measurements on the same samples. We conclude that transport in these boron carbides is via spinless singlet bipolarons.

38370 Electron spin resonance study of hot-pressed boron carbide. Venturini, E.L.; Azevedo, L.J.; Emin, D.; Wood, C. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *AIP (American Institute of Physics) Conference Proceedings;* **140**: No. 1, 292-304(15 Apr 1986). (CONF-850786—). Contract AC04-76DP00789.

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

Electron spin resonance (ESR) spectra are reported for four hot-pressed boron-rich boron carbide samples B/sub 1-x/C/sub x/ in the composition range 0.1< or =x< or =0.2. At 2 K the spectra for all four compositions are characterized by a single Lorentzian absorption with a relatively narrow linewidth and free-electron g-value. The B_4C ESR linewidth remains narrow between 2 and 295 K, while the linewidth of the other three samples containing less carbon increases by a factor of 20 over this temperature range. Above 20 K the ESR signal in the latter three samples has a lineshape that cannot be described by a single Lorentzian, but can be explained as the sum of two Lorentzians with different linewidths, suggesting the presence of two distinct paramagnetic centers. The integrated intensities of the ESR signals in all samples follow a Curie law below 100 K, and the Currie constant corresponds to spin concentrations of 2 to 3 x 10^{19} per gram. While these values are in agreement with static magnetic susceptibility data for samples cut from the same hot-pressed element, they are approximately two orders of magnitude less than the carrier densities estimated from transport measurements. This suggests that the carriers are spinless bipolarons.

38371 Brittleness dependence of crack branching in ceramics. Kirchner, H.P. (Ceramic Finishing Co., State College, PA 16804). *Journal of the American Ceramic Society;* **69**: No. 4, 339-342(Apr 1986).

A linear correlation between the degree of overloading on the crack tip and brittleness was observed. The intercept, is identified with a minimum condition of overloading where branching occurs at twice the fracture energy. The slope was identified with the degree of plastic deformation at the crack tip necessary to nucleate the branching crack. A total crack tip strain criterion for crack branching in ceramics was investigated. This criterion is supported by the fact that average total elastic strain at the boundary of the yield zone is approximately equal to the square of the slope of the curve.

38372 Electrical conductivity, Seebeck Coefficient, and structure of In_2O_3-SnO_2. Bates, J.L.; Griffin, C.W.; Marchant, D.D.; Garnier, J.E. (Pacific Northwest Lab., Richland, WA 99352). *American Ceramic Society Bulletin;* **65**: No. 4, 673-678(Apr 1986).

Indium-tin oxide compositions, commonly labeled ITO, are used as thin films, transparent heat reflectors, heterogeneous junction solar cells, protective conductive coatings, and antistatic coat-

ings. These ITO films generally contain <10%]SnO_2 and the electrical transport and optical properties of these thin films have been studied extensively. The electrical conductivities can be high, up to $\approx 10^6$ $(A.cm)^{-1}$ with the absolute conductivity values dependent on deposition method, composition, stoichiometry, oxygen partial pressure, and film thickness. The ITO films exhibit varied band gaps and are considered degenerate semiconductors with electrons as the major charge carrier. The high conduction is attributed to a defect structure resulting from charge-compensating oxygen vacancies caused by stoichiometry reduction at low oxygen pressure or doping with elements, such as Sn or F. Thin-film properties are not generally the same as bulk properties. Although bulk electrical properties have been reported for In_2O_3, SnO_2, and for doped SnO_2, none have been reported for bulk ITO. In addition, studies of the system In_2O_3-SnO_2 with >15% SnO_2 have not been reported. In the present study, electrical transport and structural properties of bulk In_2O_3-SnO_2 in air were determined as functions of temperature, structure, and composition.

38373 (N—86-21616) Effects of surface finish and grain size on the strength of sintered silicon carbide. You, Y.H.; Kim, Y.W.; Lee, J.G.; Kim, C.H. Translated from J. of the Korean Ceramic Society (Seoul, South Korea), v. 21, no. 1, 27-32(1984) *Journal of the Korean Agricultural Chemical Society ;* vp(Oct 1985). 12p. (NASA-TM—77871). NTIS, PC A02/MF A01.

The effects of surface treatment and microstructure, especially abnormal grain growth, on the strength of sintered SiC were studied. The surfaces of sintered SiC were treated with 400, 800 and 1200 grit diamond wheels. Grain growth was induced by increasing the sintering times at 2050 C. The beta to alpha transformation occurred during the sintering of beta-phase starting materials and was often accompanied by abnormal grain growth. The overall strength distributions were established using Weibull statistics. The strength of the sintered SiC is limited by extrinsic surface flaws in normal-sintered specimens. The finer the surface finish and grain size, the higher the strength. But the strength of abnormal sintering specimens is limited by the abnormally grown large tabular grains. The Weibull modulus increases with decreasing grain size and decreasing grit size for grinding.

38374 Thermodynamic analysis and kinetic implications of chemical vapor deposition of SiC from Si-C-Cl-H gas systems. Fischman, G.S.; Petuskey, W.T. (Univ. of Illinois, Urbana). *Journal of the American Ceramic Society;* 68: No. 4, 185-190(Apr 1985). Contract AC02-76ER01198.

Experimental results compiled from the literature were compared to thermodynamic calculations of the most stable proportion of condensed phases to deposit from gas mixtures of Si-C-Cl-H. The calculations indicated that the predominant gas molecules participating in a deposition process are chlorides and chlorosilanes for silicon and methane and acetylene for carbon. The mismatch of the calculated and experimentally determined phase boundaries at 1473 and 1600 K led to the conclusion that silicon deposition occurs faster than carbon deposition in proportion to their partial pressures. The probable reason is that silicon-bearing gas molecules have a greater sticking probability on polar Si and SiC surfaces because of their asymmetric geometries. 18 references, 8 figures, 3 tables.

38375 Strain isolated ceramic coatings for gas turbine engines. Tolokan, R.P.; Brady, J.B.; Jarrabet, G.P. (Brunswick Corp., DeLand, FL). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

Plasma sprayed ceramic coatings are used in gas turbine engines to improve component temperature capability and cooling air efficiency. Strain isolated ceramic coatings offer improved coating life and increased insulating capability. A low modulus fiber metal strain isolator between ceramic and metal backing acts to reduce the stress on the ceramic during thermal cycling. Strain isolated coatings can tolerate greater ceramic thickness and broader operating conditions than nonstrain isolated coatings when subjected to thermal shock. Ceramic coatings are durable only within a narrow range of operating conditions. Coating designs should be based on real operating conditions for success. Thermal shock testing is useful for evaluating ceramic coatings if test and sample design are representative of the intended application. 5 references.

38376 Characterization of copper-ceramic interfaces. Kriven, W.M.; Risbud, S.H. (Univ. of Illinois, Urbana-Champaign). *Materials Research Society Symposia Proceedings;* 40: 323-328(1985). Contract AC02-76ER01198.

The interfacial zones in copper-magnesium aluminosilicate materials were characterized by several microscopic and microchemical techniques. Interfaces between copper-glass, copper-partially crystallized glass, and copper-fully crystallized glass were studied with the specific goal of determining the oxidation state of copper in various locations in the microstructure of the reaction zones. Optical microscopy, cathodoluminescence, electron probe microanalysis (EPMA), SEM, TEM, and other microtechniques were used. The presence of copper in various oxidation states can be attributed to the thermodynamics and kinetics of the system. Results correlating the observed interfacial microstructure and the thermochemistry of the system are presented. 8 references, 6 figures, 2 tables.

38377 Mechanical prethinning and thinning of unique materials for TEM. Haltom, C.P. (Oak Ridge National Lab., TN). *Proceedings - Annual Meeting, Electron Microsopy Society of America;* 43: 180-181(1985). Contract AC05-84OR21400.

Several prethinning or mechanical dimpling devices are available for routine dimpling of ceramics prior to ion milling. Mechanical erosion thinning, to form a dimple or depression where the resulting specimen thickness is ~ 50 μm, reduces milling time. The shortened milling time is advantageous in many ways since some materials are quite friable and extended milling time often deteriorates the specimen. In other cases, where specimens of fine powder are mixed with an epoxy binder, the shortened milling time preserves the binder's integrity. Another advantage is that some specimens can be mechanically thinned to electron transparency thus eliminating artifacts which are sometimes introduced by ion milling. 4 references, 8 figures.

38378 Compositional heterogeneity in ZnO-BaO-CoO varistors. Drozdyk, L.; Payne, D.A.; Tuttle, B.A. (Univ. of Illinois, Urbana-Champaign). *Materials Letters;* 3: No. 1-2, 1-4(Nov 1984). Contract AC02-76ER01198.

SAES and STEM analyses determined heterogeneous distributions of barium at varistor grain boundary regions. The nature of the localization layers was related to thermal processing conditions and electrical properties. Interfacial distributions of barium ions at grain junctions, rather than second-phase intergranular layers, were necessary for varistor behavior. 6 references, 5 figures.

38379 Structure of alkali-zinc silicate glasses by Raman spectroscopy. Minser, D.G.; Walden, B.; White, W.B. (Pennsylvania State Univ., University Park). *Journal of the American Ceramic Society;* C47-C49(Mar 1984). Contract AC02-76ER02754.

Raman spectra were measured for a series of Na_2O x xZnO x $ySiO_2$ glasses where x = 0 to 2 and y = 1, 2, or 3. The spectra exhibit bands characteristic of sheet-like and chain-like structural units. Frequency and intensity shifts with ZnO content suggest that Zn^{2+} is a simple network modifier over this composition range. 10 references, 7 figures.

38380 Fabrication of high-field zinc oxide varistors by sol-gel processing. Lauf, R.J.; Bond, W.D. (Oak Ridge National Lab., TN). *American Ceramic Society Bulletin;* 63: No. 2, 278-281(Feb 1984). Contract W-7405-ENG-26.

Advanced ceramic processing techniques were used to fabricate ZnO varistors having grain sizes in the 3 to 4 μm range, compared to 7 to 13 μm in commercial devices. The fine-grained varistors exhibited high breakdown fields, compared to commercial materials. Processing steps included synthesis of highly active powders by sol-gel techniques and hot pressing at temperatures below about 800°C in a reducing environment to achieve high density. Heat treatment in air at temperatures up to 1000°C fully developed the nonohmic electrical properties. 13 references, 6 figures, 4 tables.

38381 State and habit of the $Fe_{16}N_2$ precipitate in b.c.c. iron: elastic theory. Hong, M.; Wedge, D.E.; Morris, J.W. Jr. (Univ. of California, Berkeley). *Acta Metallurgica;* **32**: No. 2, 279-288(1984). Contract AC03-76SF00098.

The linear elastic theory is used to determine the preferred habit of the α^3 $Fe_{16}N_2$ precipitate in α iron, assuming that the precipitate is a coherent, tetragonal phase having the form of a thin circular disc, and neglecting both surface tension effects and the difference in elastic constants between the precipitate and the iron matrix. With these approximations the precipitate habit depends on the tetragonality of the transformation strain connecting the matrix and precipitate lattices, the aspect ratio of the disc, and the elastic constants. The preferred habit of $Fe_{16}N_2$ in α iron is found to vary with the precipitate aspect ratio (K). The preferred habit changes continuously from (100) for $K < 11.35$ to an asymptote near (102) for large values of K. The results can explain the common (100) habit of $Fe_{16}N_2$, but predict that this habit is unstable when the precipitate aspect ratio is large. The theory is also used to calculate the lattice parameters of the precipitate when it is constrained within α iron. The results agree with experimental data and provide a simple explanation for discrepancies in the reported values of the lattice parameters of $Fe_{16}N_2$. 22 references, 5 figures.

38382 Ion beam modification of ceramics. McHargue, C.J.; White, C.W.; Appleton, B.R.; Farlow, G.C.; Williams, J.M. (Oak Ridge National Lab., TN). *Materials Research Society Symposia Proceedings;* **27**: 385-393(1984). Contract W-7405-ENG-26.

Alterations to the structure and properties of ceramics are complex due to the range of bonding types encountered and the necessity for maintaining local charge balance. Ion damage can occur as a result of ionizing effects as well as displacement collisions. Ion species, implantation temperature, implantation energy, and the specific bonding characteristics of the host are important parameters in determining the structure and properties of implanted ceramics. Some of these effects will be illustrated for Al_2O_3 implanted with chromium or zirconium and silicon carbide implanted with chromium. 20 references, 8 figures.

38383 Dependence of the deformation of Mn/sub 1-δ/O on the deviation from stoichiometry. Routbort, J.L. (Argonne National Lab., IL). *Materials Research Society Symposia Proceedings;* **24**: 93-99(1984).

The stress-strain behavior of <100> single crystals of Mn/sub 1-δ/O has been measured for the first time. The experiments were performed at 1200°C varying the oxygen partial pressure p/sub O_2 from 10^{-12} to 10^{-5} atms which causes the deviation from stoichiometry δ to vary between 5×10^{-2} to 2 percent. The upper yield stress and the stress achieved at a zero work-hardening rate vary by a factor of 2 as a function of δ and exhibit a maximum at p/sub $O_2 \sim 10^{-9}$ atms. The present results suggest that the diffusion of oxygen interstitials control deformation for large δ while oxygen vacancies control deformation for small δ, an interpretation used to explain the deformation Co/sub 1-δ/O. These results illustrate the intimate relationship between defect properties and deformation in nonstoichiometric oxides. 16 references, 4 figures, 2 tables.

38384 Role of Schottky disorder on the stability and structure of (100) twist grain boundaries in NiO. Wolf, D. (Argonne National Lab., IL). *Materials Research Society Symposia Proceedings;* **24**: 47-53(1984).

Recent calculations on (100) coincidence-site lattice (CSL) twist boundaries in the NaCl structure have shown that without point defects these boundaries are only marginally stable. Following an earlier suggestion that point defects are the likely source for the considerable stability of these boundaries observed experimentally for MgO and NiO, Tasker and Duffy have shown recently that the creation of a Schottky pair can, indeed, stabilize a (100) twist boundary in NiO. In this article a variety of configurations in which one or more Schottky pairs have been created in the perfect CSL or anti-CSL unit cell are investigated. It is concluded that many metastable structures may exist which differ mainly with respect to their different interfacial mass densities and the relative translation of the two halves of the bicrystal. 13 references, 2 figures, 2 tables.

38385 Time dependence of current injection phenomenon in nickel-doped MgO crystals at high temperatures. Tsang, K.L.; Tohver, H.T.; Chen, Y. (Oak Ridge National Lab., TN). *Materials Research Society Symposia Proceedings;* **24**: 207-213(1984). Contract W-7405-ENG-26.

The electrical conduction mechanisms in MgO:Ni with Pt electrodes at 1473 K are studied over electric field ranges up to ~ 10 kV/cm. The current transients induced by pulsed changes of the applied voltage as well as transient short-circuit currents have been measured and analyzed to. yield two electron hole recombination lifetimes of 10 and 250 s. The main features of the results are consistent with the double-injection model of the electrical breakdown of MgO at high temperatures. 10 references, 5 figures.

38386 Correlation between the stress and microstructure in bias-sputtered ZrO_2-Y_2O_3 films. Knoll, R.W.; Bradley, E.R. (Pacific Northwest Lab., Richland, WA). *Thin Solid Films;* **117**: 201-210(1984). Contract AC06-76RL01830.

Thin films of ZrO_2-8mol.%Y_2O_3 were produced by r.f. diode sputter deposition using applied substrate bias voltages ranging to -200 V. Unlike previous studies that employed scanning electron microscopy, transmission electron microscopy was used here to investigate changes in the grain structure, the defect structure and the columnar morphology of the films due to changes in the bias parameter. Films produced with low bias contained small (20-40 nm) intergranular voids and large intercolumnar cracks and voids. Films produced with high bias were fully dense and their microstructure resembled that of a highly stressed plastically deformed material. Measurements of the film stress showed that the intrinsic component of the film stress became increasingly compressive as the bias increased, in agreement with the microstructural data. In films deposited onto SiO_2 substrates the total stress ranged from $+6 \times 10^8$ Pa (tensile) in unbiased films to -1.7×10^9 Pa (compressive) in films produced with -200 V applied substrate bias. 20 references, 3 figures.

38387 Grain-boundary microstructures in a commercial alumina ceramic. Hansen, S.C.; Shiue, Y.R.; Phillips, D.S. (Univ. of Illinois, Urbana-Champaign). *Advances in Ceramics;* **6**: 163-170(1983). Contract AC02-76ER01198.

Grain-boundary structures in a commercial alumina refractory have been investigated with transmission electron microscopy. An intergranular glass is found which shows that the material was sintered by a liquid-phase process. In addition to this glass, both annealing twins and boundary facets are observed which show that boundary structures containing glass need not be random. Both features are expected results of ledge-growth models and both indicate that interfacial energies in the system are anisotropic. 11 references, 5 figures, 1 table.

3603 Composite Materials

38388 (CONF-860829—19) Strain contrast in SiC whisker reinforced Al_2O_3. Angelini, P.; Mader, W. (Oak Ridge National Lab., TN (USA); Max-Planck-Institut fuer Metallforschung, Stuttgart (Germany, F.R.); Max-Planck-Institut fuer Metallforschung, Stuttgart (Germany, F.R.). Inst. fuer Werkstoffwissenschaften). 1986. Contract AC05-84OR21400. 3p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009537.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Whisker reinforced ceramic materials offer the potential for increased fracture toughness and fracture strength. Residual stresses resulting from differences in thermal expansion properties of the matrix and the whisker can develop during cooling and affect mechanical properties. TEM strain contract of large inclusions has previouly been observed for nearly spherical particles of ZrO_2 in Al_2O_3 matrix grains. The formation of strain contrast oscillations was explained and a quantitative analysis of strains around ZrO_2 inclusions in Al_2O_3 was performed. The present research is concerned with characterizing by TEM the strain field present in Al_2O_3 reinforced with SiC whiskers.

38389 (CONF-8504245—) **Proceedings of the second annual review of the center for composite materials and structures.** (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Apr 1985. 346p. NTIS, PC A15/MF A01.

From 2. annual review of the Center for Composite Materials and Structures; Blacksburg, VA, USA (23 Apr 1985).

Topics covered include: finite element models; geometric analysis; failure analysis of graphite-epoxy laminates; fracture mechanics; modeling cured laminates; edge reinforcement concepts; nondestructive testing; impact damage to thick composite laminates; and prediction analysis techniques.

38390 (CONF-8504245—, pp vp) **Thermally induced stresses and deformations in layered composite tubes.** Cooper, D.E.; Cohen, D.; Rousseau, C.Q.; Hyer, M.W.; Tompkins, S.S. (Virginia Polytechnic Institute and State Univ., Blacksburg). Apr 1985. NTIS, PC A15/MF A01.

From 2. annual review of the Center for Composite Materials and Structures; Blacksburg, VA, USA (23 Apr 1985).

The thermally induced stresses and deformations in layered, orthotropic tubes are studied. The motivation for studying tubes is their likely application for use in space structures. Tubes are a strong candidate for this application because of their high structural efficiency, as measured by stiffness per unit weight, and their relative ease of fabrication. Also, tubes have no free edges to deteriorate or delaminate. An anticipated thermal condition for tubes in space is a circumferential temperature gradient. This type of gradient will introduce dimensional changes into the structure and may cause stresses large enough to cause damage to the material. There are potentially large differences in temperatures at different circumferential locations on the tube. Because of this, the effects of temperature dependent material properties on the stresses and deformations may be important. The study is composed of three parts: experiments to determine the functional form of the circumferential gradient and to measure tube deflections; an elasticity solution to compute the stresses and deformations; and an approximate approach to determine the effects of temperature dependent material properties.

38391 (DTH-ABK-R—206) **Fatigue tests of adhesively bounded joints between steel and glass fiber laminates.** Brincker, R.; Stang, H. (Danmarks Tekniske Hoejskole, Lyngby. Afdelingen for Baerende Konstruktioner). 1985. 80p. (In Danish). Danmarks Tekniske Hoejskole, Lyngby. Afdelingen for Baerende Konstruktioner.

EFP.

This report deals with the fatigue strength of adhesively bonded joints between steel and a glass fibre laminates. A test programme is described which consisted of classical fatigue tests as well as fatigue crack growth measurements. The test results are intepreted by means of linear elastic fracture mechanics and the so-called Paris' law, which proved suitable for describing classical fatigue tests as well as crack growth tests.

38392 (SAND—86-0784) **Mechanical properties of unidirectional and fabric graphite/epoxy composites.** Guess, T.R. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1986. Contract AC04-76DP00789. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012077.

Room-temperature tension, compression, flexural, short beam shear, and inplane shear test results are presented for unidirectional and fabric reinforced graphite/epoxy composites. The reinforcement was 34 million psi modulus graphite fibers: Celion 12K in a unidirectional material and Thornel 300 in a fabric composite of 24 x 23 ends/inch eight-harness satin weave fabric. Both composites used a 350°F epoxy resin, CE-9000, for the matrix material. The elastic and strength properties of the unidirectional specimens were in good agreement with analytical predictions and with literature values for similar materials. The tensile stress-strain curves of the unidirectional and fabric composites were linear elastic to failure; whereas, the compression curves exhibited some nonlinearity near failure. A slight degree of anisotropy (less than 5%) was observed between the properties in the warp and fill directions of a fabric composite in which the individual plies of fabric were warp aligned. This anisotropy is attributed to the fact that there is about 4% more fiber reinforcement in the warp direction than in the fill direction of the fabric.

3604 Polymers And Plastics

REFER ALSO TO CITATION(S) 37752

38393 (LA-UR—86-1565) **Effect of chain rigidity on conductivity of conjugated polymers.** Aldissi, M. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-8606133—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011263.

From International conference on science and technology of synthetic metals; Kyoto, Japan (1 Jun 1986).

There are several ways to introduce processability to conjugated polymers, and one of them is discussed here. The basic approach involves the introduction of flexible centers in a conjugated backbone with a periodicity that allows the existence of conjugated sequences characterized by an electron mobility high enough to result in electronic conduction upon oxidation or reduction. The process consists of the use of AsF_5 as a polymerization catalyst, and AsF_3 as a non-conventional medium for the reaction. The Lewis acid coupling reactions, via which the polymerization occurs, result in soluble materials. Characteristics of the materials obtained by polymerizing acetylene and some aromatic compounds are discussed.

38394 (LA-UR—86-1744) **Physical characteristics of diblock polyacetylene copolymers: processability-conductivity correlation.** Aldissi, M.; Hou, M.; Farrell, J. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-8606133—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011218.

From International conference on science and technology of synthetic metals; Kyoto, Japan (1 Jun 1986).

The physical properties of polyacetylene diblock copolymers containing polystyrene (PS) or polyisoprene (PI) blocks of various compositions are studied using electron spin resonance, resonance Raman scattering, and room temperature conductivity measurements. This study is performed to investigate the processability-conductivity correlation in these materials and their viability as conducting systems.

38395 **Order-disorder transitions of π-conjugated polymers in condensed phases. I. General theory.** Schweizer, K.S. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Chemical Physics;* 85: No. 2, 1156-1175(15 Jul 1986). Contract AC04-76DP00789.

A novel statistical mechanical theory for the order-disorder transformations of conjugated polymers in dilute solution and neat amorphous films is proposed. Single chain configurational statistics and the conformation-dependent polymer-solvent interactions are included in the basic formulation. Abrupt transition phenomena arise from the energetic stabilization of the rod-like conformation via the interaction of the delocalized electrons of the polymer backbone with the surrounding polarizable solvent. The theory is developed in detail for π-conjugated polymers (polyenes and polydiacetylenes) in dilute solution and makes a significant number of qualitative and quantitative predictions. Available experimental data are consistent with the theoretical picture and a variety of additional experiments are suggested to critically test the proposed ideas. The statistical mechanical formalism is generalized to allow for intramolecular hydrogen bonding, polydispersity, solvent mixtures, defect correlations, and substituent disorder. These effects have quantitative consequences but do not change the qualitative physics of the proposed three-dimensional solvation mechanism for the coupled electronic-conformational transitions. Preliminary application of the theory to amorphous films is briefly considered.

38396 **Deuterium permeation properties of beta-irradiated and unirradiated poly(vinyl alcohol) and polystyrene shells.** Scott, L.A.; Schneggenburger, R.G.; Anderson, P.R. (KMS Fusion Inc., Ann Arbor, Michigan 48106). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1155-1159(May 1986). Contract AC08-82DP40152.

We measured the permeability of inertial fusion (IF) fuel shells made of poly(vinyl alcohol) (PVA) and polystyrene (PS) with deuterium. Activation energies of permeation (E/sub p/) were

determined using permeability coefficients measured over the temperature range 25—100°C for PVA, and -100 to 25°C for PS shells. We then exposed this same batch of shells to intense beta irradiation from tritium and repeated the permeation measurements. Comparing permeabilities of the same shells before and after irradiation, we obtained a measure of the effect beta irradiation has on fuel retention characteristics of the polymers. Our results show that irradiation does change the permeability of PVA, while the permeability of irradiated PS is relatively unchanged.

38397 Nonlinear analysis of the inflation of an initially flat, circular, elastic disk. Christensen, R.M.; Feng, W.W. (Lawrence Livermore, National Laboratory, University of California, Livermore, California 94550). *Journal of Rheology;* 30: No. 1, 157-165(Feb 1986). Contract W-7405-ENG-48.

An approximate analysis is given for the inflation of a thin, flat circular disk of elastomeric material. The analysis results in a closed-form analytical solution for the maximum displacement as a function of pressure. The method is illustrated through the use of a Mooney-Rivlin material model. The results are compared with the exact solution, obtained by numerical means, and they are satisfactory, up into the range of several hundred percent strain. The method greatly simplifies the procedure for reducing test data, from this type of test, to nonlinear range mechanical properties.

38398 Regularization and inverse problems in viscoelasticity. Hedstrom, G.W.; Thigpen, L.; Bonner, B.P.; Worley, P.H. (Lawrence Livermore National Lab., CA). *Journal of Applied Mechanics;* 51: 121-124(Mar 1984). Contract W-7405-ENG-48.

The method of constrained regularization is used to invert for retardation spectra and attenuation from the creep data of a commercial-grade lucite material. Four different criteria for choosing a regularization parameter in the solution of the first-kind integral equation are examined. Although the spectra are different, computations using each criterion give essentially the same attenuation curve for a range of frequencies. These results show that reliable estimates of the attenuation may be obtained from inversion of creep data using the method of constrained regularization. 9 references, 6 figures.

38399 Turbulent boundary layer treatment for reacting polymer jets. Johnson, J.A. III; Santiago, J.P. (CUNY, New York). *Polymer Communications;* 25: 34-35(Feb 1984). Contract AC02-83ER13041.

The Orr-Sommerfield solutions are applied to low speed liquids near transition to turbulence and the trends for measured gel times in colliding free inflected flows are obtained. 14 references, 1 figure.

38400 New treatment of the theory for small-angle x-ray scattering with applications to polystyrene crazes. Tang, M.Y.; Fellers, J.F. (Univ. of Tennessee, Knoxville). *Journal of Polymer Science, Polymer Physics Edition;* 22: 2215-2241(1984).

The phenomenon of surface scattering of electromagnetic waves by single or multiple layers of films is reviewed and a special treatment for the total reflection of x rays is developed. This theory is applied to the analysis of the surface scattering observed in small-angle x-ray scattering (SAXS) studies of two-phase matter in polymers having lamella stacks or a flat interfacial boundary structure. Important features of this vector theory are the ability to calculate the surface scattering invariant, the absolute scattering intensity, and the surface roughness, which gives rise to dispersion of specular reflection from perfectly smooth surfaces. By considering the interfacial surface roughness of polystyrene crazes, the surface scattering spectrum is calculated theoretically and compared with some experimental results. Also the theory is presented in a way as to compare surface scattering with volume scattering. This provides a new basis for quantitative analysis of crazes in polystyrene. 42 references, 20 figures, 1 table.

3606 Other Materials

REFER ALSO TO CITATION(S) 37307, 37691, 37734, 37734, 37741, 37749, 37790, 38197, 38319, 38356, 38358, 38359, 38484, 38598, 38598, 38602, 38602, 38606, 38606, 38607, 38607, 38608, 38608, 38611, 38645, 38655, 38998, 38999, 39000, 39001, 39420

38401 (CONF-860605—14) Radiolytic gas generation from cement-based waste hosts for DOE low-level radioactive wastes. Dole, L.R.; Friedman, H.A. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012201.

From 13. international symposium on the effects of radiation on materials; Seattle, WA, USA (23 Jun 1986).

Using cement-based immobilization binders with simulated radioactive waste containing sulfate, nitrate, nitrite, phosphate, and fluoride anions, the gamma- and alpha-radiolytic gas generation factors (G/sub t/, molecules/100 eV) and gas compositions were measured on specimens of cured grouts. These tests studied the effects of; (1) waste composition; (2) the sample surface-to-volume ratio; (3) the waste slurry particle size; and (4) the water content of the waste host formula. The radiolysis test vessels were designed to minimize the "dead" volume and to simulate the configuration of waste packages.

38402 (CONF-860826—2) Determining leach rates of monolithic waste forms. Gilliam, T.M.; Dole, L.R. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012618.

From National meeting of the American Institute of Chemical Engineers; Boston, MA, USA (24 Aug 1986).

The ANS 16.1 Leach Procedure provides a conservative means of predicting long-term release from monolithic waste forms, offering a simple and relatively quick means of determining effective solid diffusion coefficients. As presented here, these coefficients can be used in a simple model to predict maximum release rates or be used in more complex site-specific models to predict actual site performance. For waste forms that pass the structural integrity test, this model also allows the prediction of EP-Tox leachate concentrations from these coefficients. Thus, the results of the ANS 16.1 Leach Procedure provide a powerful tool that can be used to predict the waste concentration limits in order to comply with the EP-Toxicity criteria for characteristically nonhazardous waste. 12 refs., 3 figs.

38403 (IS-M—584) Density of states at mid gap in hydrogenated amorphous silicon. Yahya, E.; Shanks, H.R. (Ames Lab., IA (USA)). 1986. Contract W-7405-ENG-82. 6p. (CONF-8604210—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011403.

From 3. international symposium on optical and optoelectrical applied science and engineering; Innsbruck, Austria (14 Apr 1986).

The density of states distributions near mid gap in a series of hydrogenated amorphous silicon films have been determined from space charge limited current measurements. The measurements were made on Au/aSi:H Schottky diode structures prepared by reactive rf sputter deposition. Samples with hydrogen concentrations near 16% as determined from infrared absorption had densities of states of 3 x 10^{16} states/cm^3 eV. The experimental results indicate that high quality aSi:H films with low densities of states can be obtained under certain deposition conditions and that the density of states at mid gap is hydrogen concentration dependent with a minimum near 16%. For a given hydrogen concentration, films thicker than 2 μm yielded the lowest density of states consistent with a model in which diffusion currents can be neglected and where surface and interface layers have a higher defect density than the bulk of the film. 7 refs., 8 figs.

38404 **(KMSF-U—1761) Crystal R/sub c/ calibrations with an uncollimated, point x-ray source.** Rockett, P.D.; Bird, C.R.; Hailey, C.J. (KMS Fusion, Inc., Ann Arbor, MI (USA)). 1986. Contract AC08-82DP40152. 11p. (CONF-860880—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011867.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

The calibration of crystal integrated reflectivity can be faithfully performed with an uncollimated, well-filtered point x-ray source. In this geometry the angle of illumination of the crystal greatly exceeds the crystal rocking angle. The crystal essentially collimates the scattered beam, establishing the detector acceptance angle. We have measured single crystal R/sub c/'s in this way for a variety of crystals including PET, Beryl, LiF (200), several synthetic multilayers, silicon (111), and KAP.

38405 **(LA-UR—86-2158) Muon channeling in Ge: evidence for pionium formation.** Flik, G.; Bradbury, J.N.; Cooke, D.W.; Heffner, R.H.; Leon, M.; Paciotti, M.A.; Schillaci, M.E.; Maier, K.; Rempp, H.; Boekema, C. (Los Alamos National Lab., NM (USA); Max-Planck-Institut fuer Metallforschung, Stuttgart (Germany, F.R.); San Jose State Univ., CA (USA); Mississippi Univ., University (USA); Technische Univ. Muenchen, Garching (Germany, F.R.)). 1986. Contract W-7405-ENG-36. 6p. (CONF-8606134—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012446.

From 4. international conference on muon spin rotation, relaxation and resonance; Uppsala, Sweden (1 Jun 1986).

In a recent experiment observing muon channeling from the decay of positive pions implanted in high-purity Ge single crystals, the pion decay site is found to be sensitive to the concentration of excess charge carriers produced by photon absorption. Distinctly different channeling profiles are observed in Ge at 100°K for illuminated samples (high carrier concentration) as compared to unilluminated samples (low carrier concentration). From these data we conclude that different electronic states of the pion in a semiconductor host lattice must account for the observed changes in the pion location. Furthermore, we suggest that the pion exists in the solid both as the bare entity π^+ and as pionium (π^+e^-), i.e., a hydrogen-like atom with a mesonic nucleus.

38406 **(LA-UR—86-2232) Magnetic behavior in the U/sub 1-x/Th/sub x/Cu_2Si_2 system.** Giorgi, A.L. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 5p. (CONF-860608—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012429.

From World congress on high tech ceramics: electronic, engineering, nuclear, biomedical research and applications in focus; Milan, Italy (23 Jun 1986).

The compound UCu_2Si_2 has been found to be ferromagnetic at low temperatures with a Curie temperature of 101°K. The magnetization follows a Curie-Weiss law in the paramagnetic region with an effective magneton number of 2.12 Bohr magnetons per uranium atom. Partial substitution of Th atoms for the U atoms results in an expansion of the lattice, a rapid drop in the Curie temperature, and a sizable increase in the coercive field.

38407 **(LBL—21356) Analysis of semiconductor EELS in the low-loss regime.** Kundmann, M.K. (Lawrence Berkeley Lab., CA (USA)). Apr 1986. Contract AC03-76SF00098. 18p. (CONF-860829—28). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011314.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

The low-loss regime (0 to 100eV) in electron energy-loss spectra has largely been ignored by the AEM community owing to its complexity and the dominance of plasmons. However, the low-loss regime contains, by far, most of the inelastic events recorded in an energy-loss spectrum (ELS) and is of interest. A method of analysis which overcomes the above difficulties and allows the structure of spectra to be unraveled is described here. The method has been applied to semiconductors, but is likely to be applicable to some metals as well. The analysis involves two steps, multiple scattering correction followed by plasmon-background modeling and subtraction. The validity of these procedures depends upon the experimental conditions under which spectra are collected, hence a brief description of the experimental set-up used to acquire spectra is given.

38408 **(LBL—21431) Computer simulated images of platinum clusters in Y zeolite.** Csencsits, R.; O'Keefe, M.A.; Chan, I.Y.; Gronsky, R. (Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098. 5p. (CONF-860829—29). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011586.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

High resolution electron microscopy is a valuable technique for studying catalytic metals and their zeolite supports because it allows direct visualization of their microstructure. The question is: what is the smallest metal particle that can be detected by electron microscopy in such a system. Our goal is to determine the conditions under which a small (13 atoms) platinum cluster inside a Y zoelite channel can be detected by HREM.

38409 **(LBL—21604) Effect of magnetic fields on the electronic structure of density-wave systems.** Falicov, L.M.; Balseiro, C.A. (Lawrence Berkeley Lab., CA (USA); Comision Nacional de Energia Atomica, San Carlos de Bariloche (Argentina). Centro Atomico Bariloche). May 1986. Contract AC03-76SF00098. 7p. (CONF-8605146—2). NTIS, PC A02/MF01; GPO Dep. File Number DE86011921.

From 15. Yamada conference on physics and chemistry of quasi one-dimensional conductors; Lake Kawaguchi, Japan (26 May 1986).

The effect of high magnetic fields on the elctronic structure of density-wave systems is examined. Small electron and hole pockets, caused by the density wave, may be obliterated by the magnetic field. The phenomenon is highly anisotropic, changes drastically the energy spectrum and may considerably enhance the density-wave critical temperature, in some cases. The theory applies to recent experiments in niobium triselenide and in the TMTSF salts. 17 refs., 1 fig.

38410 **(SAND—85-2602) Development and implementation: Test Series A of the Small-Scale Seal Performance Tests.** Stormont, J.C. (ed.). (Sandia National Labs., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 53p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012251.

The first in a series of in situ experiments to evaluate candidate salt repository sealing materials and sealing configurations has been initiated in the Waste Isolation Pilot Plant. Test Series A of the Small-Scale Seal Performance Tests is providing structural/thermal and fluid-flow information for the evaluation of a newly developed expansive salt-water-based concrete. This report provides information necessary for evaluating these data, including "as-built" test configurations, instrumentation development and specifications, development and properties of the concrete, and applicable rock properties. Also included are descriptions of some activities required to implement this test, such as drilling and seal and instrumentation emplacement.

38411 **(SAND—85-2830C) Kinetic and thermodynamic studies of pulsed laser irradiation.** Peercy, P.S.; Thompson, M.O. (Sandia National Labs., Albuquerque, NM (USA); Cornell Univ., Ithaca, NY (USA)). 1986. Contract AC04-76DP00789. 10p. (CONF-860620—8). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012175.

From Society of Photo-Optical Instrumentation Engineers international symposium: topics in optical and optoelectronic applied sciences and engineering; Quebec City, Canada (2 Jun 1986).

Simultaneous measurements of the transient conductance, to determine the molten layer thickness versus time, and the time-dependent surface reflectance, to determine the melt duration at the surface during pulsed laser irradiation, are reviewed. These real-time measurements have been applied in a variety of studies of Si and Si-based alloys. In crystalline Si, melt initiates at the surface and propagates to some depth, whereupon the motion of the liquid/

solid interface reverses and the material solidifies. In amorphous Si, these measurements were used to determine the melting temperature of the amorphous phase and the mechanism by which explosive crystallization occurs. In Si implanted with impurities, combined transient conductance and reflectance measurements reveal the occurrence of such novel melt and solidification scenarios as internal nucleation of melt and surface nucleation of solid on molten Si. Internal melts, which were previously unexpected, appear to be quite common and explain unusual microstructures observed by TEM.

38412 **(SAND—86-0609C) Angular dependence of the auger lineshape of graphite.** Rogers, J.W. Jr.; Houston, J.E.; Rye, R.R. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 7p. (CONF-860829—10). NTIS, PC A02/MF A01; GPO Dep. File Number DE86008406.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

The Auger lineshape of graphite is of interest as a model for studying initial-state, core-hole screening and final-state, hole-hole correlation effects in aromatic systems. We have obtained the Auger spectra from POCO (amorphous) and HOPG (highly-oriented pyrolytic) graphite.

38413 **(UCRL—87475) Effect of gamma irradiation on the strength of Climax stock quartz monzonite.** Durham, W.B. (Lawrence Livermore National Lab., CA (USA)). 31 Mar 1982. Contract W-7405-ENG-48. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012338.

A laboratory study was made of the effects of a massive dose of γ irradiation upon the mechanical properties of Climax stock quartz monzonite. Twenty-nine cylinders of rocks were tested using the Brazilian method and 26 strain gauged cylinders were tested to failure in uniaxial compression. One-half the cylinders in each group were subjected to a γ ray dose of 13.2 MGy (1.32×10^9 rads), or six times the maximum five-year dose to rock at the Spent Fuel Test-Climax, Nevada Test Site. The irradiation treatment lowered the ultimate compressional strength and lowered Young's modulus under uniaxial loads greater than 20 MPa. The treatment did not measurable affect the elastic behavior of the rock in compression, nor did it affect the Brazilian tensile strength. These trends suggest that the γ irradiation lowered the threshold stress at which microfractures begin to form. The irradiation has apparently not directly induced microfracturing in the rock, so a direct degrading effect on thermal and fluid transport properties is not expected.

38414 **Conditions for uniform growth of GaAs/sub 1-// sub x-italic/P/sub x-italic/ superlattices.** (Solar Energy Research Institute, Golden, Colorado 80401). *Journal of Applied Physics;* **60**: No. 3, 1206-1208(1 Aug 1986). Contract AC02-83CH10093.

Nonplanar morphology and compositional inhomogeneity are observed in GaAs/sub 1-//sub x-italic/P/sub x-italic/ superlattices when the phosphorus content is substantially different in adjacent sublayers. The main characteristic feature of the distortion is a series of ribbonlike regions running through the superlattice which etch at a faster rate and contain more phosphorus than the surrounding material and are also the source of clusters of dislocations. Morphological stability and a general decrease in dislocation density can be effected by decreasing the interlayer strain, i.e., compositional difference, between the superlattice sublayers.

38415 **Photo Hall-effect characterization of closely compensated Ge:Be.** (Lawrence Berkeley Laboratory and University of California, Berkeley, California 94720). *Journal of Applied Physics;* **60**: No. 3, 1055-1058(1 Aug 1986). Contract AC03-76SF00098.

The temperature dependence of the free-carrier concentration in germanium doped with the double acceptor Be has been investigated using the photo Hall-effect technique and found to be strongly temperature dependent when the residual shallow impurities are closely compensated. Close compensation (N-italic/sub A-italic/≅N-italic/sub D-italic/) of shallow levels was achieved by controlling the concentration of a beryllium—hydrogen acceptor complex A-italic(Be,H) which is present in crystals grown under a H_2 atmosphere. This complex can be removed with high-temperature annealing. An increase of up to two orders of magnitude in free-carrier lifetime as a function of temperature is found to occur between 5 and 11 K in closely compensated material due to the population inversion of ionized centers created by optical pumping.

38416 **Zinc-implantation-disordered (InGa)As/GaAs strained-layer superlattice diodes.** (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Applied Physics;* **60**: No. 3, 1131-1134(1 Aug 1986). Contract AC04-76DP00789.

We have examined the properties of (InGa)As/GaAs strained-layer superlattices (SLSs) that have been disordered by implantation of $5 \times 10^{15}/cm^2$, 250 keV $^{64}Zn^+$ followed by controlled atmosphere annealing at 680°C for 30 min. Ion channeling techniques indicate that the Zn-disordered regions of the SLS contain extensive crystalline damage after annealing. Simulations of the disordering process using an analytic ion range code predict that the electrical junction resulting from the implantation process is located outside the disordered region of the SLS in both the vertical and the lateral directions. Junction electroluminescence intensity for given drive current densities from the Zn-disordered SLS devices is comparable to that from reference Be-implantation-doped (SLS retained) devices and greatly exceeds that from heavily dislocated grown-junction mesa diodes in the homogeneous alloy of the average SLS composition; this result is consistent with the results of the simulations. This study demonstrates that implantation disordering can be as useful for strained-layer systems as for less severely mismatched heterojunction systems.

38417 **Molecular beam epitaxial growth of a novel strained-layer superlattice system: CdTe-ZnTe.** (University of Illinois at Chicago, Department of Physics, P.O. Box 4348, Chicago, Illinois 60680). *Applied Physics Letters;* **49**: No. 3, 152-154(21 Jul 1986).

CdTe-ZnTe strained-layer superlattices have been grown for the first time using the molecular beam epitaxy technique. The superlattices have been grown at 285 °C. They have been characterized by electron and x-ray diffraction. The presence of satellite peaks in the x-ray spectra shows that the superlattices are of excellent quality despite the large mismatch between CdTe and ZnTe along the growth axis (Δa-italic/a-italic = 6.4%). X-ray oscillation patterns show that the superlattices are three-dimensional crystals.

38418 **Temperature dependence of the refractive index of silicon at elevated temperatures at several laser wavelengths.** Jellison, G.E. Jr.; Burke, H.H. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Applied Physics;* **60**: No. 2, 841-843(15 Jul 1986). Contract AC05-84OR21400.

The refractive index of silicon has been measured at elevated temperatures at several different laser wavelengths of the HeNe and the Ar^+ cw lasers. This data, along with the reinterpretation of polarization modulation ellipsometry data, shows that the refractive index is linear with temperature (from 25 to ~750°C) and that the temperature coefficient of the refractive index increases as the wavelength of light decreases.

38419 **Submicron silicon powder production in an aerosol reactor.** (Division of Engineering and Applied Science, California Institute of Technology, Pasadena, California 91125). *Applied Physics Letters;* **49**: No. 2, 82-84(14 Jul 1986).

Powder synthesis by thermally induced vapor phase reactions is described. The powder generated by this technique consists of spherical, nonagglomerated particles of high purity. The particles are uniform in size, in the 0.1—0.2 μm size range. Most of the particles are crystalline spheres. A small fraction of the spheres are amorphous. Chain agglomerates account for less than 1% of the spherules.

38420 Diffusion dynamics of holes in In/sub x-italic/Ga/sub 1-//sub x-italic/As/GaAs strained-layer superlattices. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Applied Physics Letters;* 49: No. 2, 100-102(14 Jul 1986). Contract AC04-76DP00789.

We investigate the diffusion dynamics of minority-carrier holes in In/sub 0.2/Ga/sub 0.8/As/GaAs strained-layer superlattices by measuring their diffusion lengths, both parallel and perpendicular to the layers, and recombination lifetime for temperatures between 78 and 300 K. From these data we determine a phenomenological hopping time for interlayer motion. We also estimate the valence-band barrier heights which govern this motion, by studying the interband quantum well optical transition energies over the same temperature range.

38421 Distributions of residual stress, dislocations, and EL2 in Czochralski-grown semi-insulating GaAs. Dobrilla, P.; Blakemore, J.S. (Oregon Graduate Center, Beaverton, Oregon 97006). *Journal of Applied Physics;* 60: No. 1, 169-176(1 Jul 1986). Contract AC04-76DP00789.

Distributions of stress, dislocations, and the EL2 midgap defect have been optically mapped in semi-insulating GaAs wafers, from [100]-grown crystals created by the liquid-encapsulated Czochralski method. The evolution of EL2 along the growth axis indicates that assessment of this property through the majority of the crystal volume is often poorly represented by wafers from near the two end regions. A comparison of maps for stress, dislocation and EL2 patterns as all measured with a given wafer does not support hypotheses that EL2 is a direct consequence either of stress or of dislocations. Other mechanisms, such as segregation and melt dynamics, thus appear more likely to control the formation and distribution of EL2.

38422 Study of the defect structures in CdTe crystals using synchrotron x-ray topography. (Center for Materials Research, Stanford University, Stanford, California 94305). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 4, 2190-2194(Jul 1986).

Synchrotron x-ray topography has been used to study structural defects in CdTe crystals. Substrates from six commercial sources as well as crystals grown in our own laboratory by the vertical Bridgman method were studied. X-ray topography is known to be very sensitive to lattice strain and it reveals a broad range of defects. Extensive subgrain structure was detected in virtually all substrate material studied, in basic agreement with chemical etching, cathodoluminescence, and double crystal rocking curve (DCRC) analysis. Dislocations, dislocation tangling, and microprecipitates were revealed as well. In addition, we found extensive slip systems and large, long-range misorientations (average 200—500 arc s). These findings suggest there may be serious problems with mechanical and/or thermal stresses during the growth of CdTe. We also include results from preliminary studies on ZnCdTe substrates.

38423 Surface solidification and impurity segregation in amorphous silicon. Peercy, P.S.; Poate, J.M.; Thompson, M.O.; Tsao, J.Y. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Applied Physics Letters;* 48: No. 24, 1651-1653(16 Jun 1986). Contract AC04-76DP00789.

Real-time measurements of the melt and solidification dynamics during pulsed laser irradiation have permitted elucidation of the processes which lead to the formation of very thin (~2 nm) buried impurity layers in amorphous silicon. These novel structures are found to result from interfacial segregation at two moving liquid silicon-amorphous silicon interfaces: one propagating toward the surface and the other propagating from the surface inward. The velocities of these interfaces are found to be remarkably low, ranging from 1 to 8 m/s for melts of <20 ns duration.

38424 Electrical transport of holes in GaAs/InGaAs/GaAs single strained quantum wells. Fritz, I.J.; Drummond, T.J.; Osbourn, G.C.; Schirber, J.E.; Jones, E.D. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Applied Physics Letters;* 48: No. 24, 1678-1680(16 Jun 1986). Contract AC04-76DP00789.

We report electrical transport data for holes in single strained quantum well structures of the type GaAs/In/sub x/Ga/sub 1-x/As/GaAs with xroughly-equal0.2. With modulation doping, 4 K mobilities of ~3 x 10^4 cm^2/V s have been achieved. This value is near that attained for electrons in comparable structures, illustrating the enhanced transport possible due to the strain-induced light-hole planar mass.

38425 Quantitative analysis of streaks in reflection high-energy electron diffraction: GaAs and AlAs deposited on GaAs(001). Lent, C.S.; Cohen, P.I. (Department of Electrical Engineering, University of Minnesota, Minneapolis, Minnesota 55455). *Physical Review [Section] B: Condensed Matter;* 33: No. 12, 8329-8335(15 Jun 1986). Contract FG02-84ER45173.

Reflection high-energy electron diffraction (RHEED) has long been considered a qualitative tool for assessing the roughness of a surface and for determining whether thin films are deposited epitaxially. Though this technique is known to be exceedingly surface sensitive, no quantitative statements could be made. In this paper we report measurements of the specular diffraction beam from near-singular GaAs(001) surfaces with submonolayer deposits of GaAs and AlAs. By fitting the shapes of these beams to a kinematic calculation, exact to within the column approximation, we determine the coverages of the surfaces and estimate the average island size in the overlayer. The results show the sensitivity of RHEED to the details of the island or step distribution on the surface. By comparing the AlAs and GaAs profiles it is apparent that Al is much less mobile on the (001) surface than is Ga. Finally we report the observation of surface roughening during the 2 x 4 to c(4 x 4) GaAs(001) phase transition.

38426 Band-gap shifts in heavily doped n-type GaAs. Sernelius, B.E. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831; Department of Physics, University of Tennessee, Knoxville, Tennessee 37916). *Physical Review [Section] B: Condensed Matter;* 33: No. 12, 8582-8586(15 Jun 1986). Contract AC05-84OR21400.

We present theoretical results for the band-gap shifts in heavily doped n-type GaAs. We find that the bands are far from being shifted rigidly. The states at the band edges are shifted more than the states with Fermi momentum. Consequently, the band-gap narrowing deduced from absorption experiments is strongly underestimated. Our results are compared to those from experiments on photoluminescence, cathodoluminescence, and diode-injection luminescence and from absorption measurements. Agreement is found with all the experimental results and we give a new explanation for the position of the luminescence peak in the diode-injection experiments and its shift with varying forward bias voltage.

38427 Central-cell and screening effects on the binding energies of neutral chalcogen impurities in silicon. Oliveira, L.E.; Falicov, L.M. (Department of Physics, University of California, Berkeley, California 94720; Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review [Section] B: Condensed Matter;* 33: No. 12, 8765-8767(15 Jun 1986). Contract AC03-76SF00012.

The binding energies of D^0 states in S-, Se-, and Te-doped silicon crystals are calculated within a variational scheme in the effective-mass approximation and with a Chandrasekhar-type variational function for the two-electron envelopes. Central cells are modeled with a constant core potential within the impurity sphere. Screening effects for the potential and the electron-electron interaction are taken into account by means of a position-dependent dielectric function. Results are compared with recent theoretical and experimental work. It is found that central-cell effects and position-dependent screening are essential to account for the experimental data.

38428 Ordered structures in GaAs/sub 0.5/Sb/sub 0.5/ alloys grown by organometallic vapor phase epitaxy. Jen, H.R.; Cherng, M.J.; Stringfellow, G.B. (Department of Materials Science and Engineering, University of Utah, Salt Lake City, Utah 84112). *Applied Physics Letters;* 48: No. 23, 1603-1605(9 Jun 1986). Contract FG02-84ER45061.

Electron diffraction measurements on (100) GaAs/sub 1-x/ Sb/sub x/ layers with xroughly-equal0.5 grown by organometallic vapor phase epitaxy indicate that ordered phases are formed during growth. Two ordered phases are observed. The simple, tetragonal AuCu-I type phase consists of alternating {100} oriented GaAs and GaSb layers. Only the two variants with the tetragonal c axes perpendicular to the growth direction are observed. At least two variants are observed for the chalcopyrite $E1_1$ structure with alternating {210} oriented GaAs and GaSb layers.

38429 Derivative photocurrent spectrum of an InGaAs/GaAs strained-layer superlattice. Fritz, I.J.; Doyle, B.L.; Drummond, T.J.; Biefeld, R.M.; Osbourn, G.C. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Applied Physics Letters;* **48**: No. 23, 1606-1608(9 Jun 1986). Contract AC04-76DP00789.

We report the use of wavelength-modulated photocurrent spectroscopy to obtain detailed information on quantum well transitions in an In/sub 0.14/Ga/sub 0.86/As/GaAs strained-layer superlattice. The spectra are interpreted in terms of a Kronig—Penney model with literature values for offsets and deformation potentials. The effect of the test structure's built-in electric field must be included to obtain agreement with this theory.

38430 Fine diamond turning of KDP crystals. (Lawrence Livermore National Laboratory, Materials Fabrication Division, Optics Group, P.O. Box 808, Livermore, California 94550). *Applied Optics;* **25**: No. 11, 1733-1735(1 Jun 1986). Contract W-7405-ENG-48.

Frequency doubling optical components for the Nova laser system are made from single-crystal potassium dihydrogen phosphate (KDP). While developing a manufacturing process for these components, we found that single-point diamond turning could be used to directly produce finished parts with no need for additional surface polishing. A surface roughness of better than 8-A rms and 36-A P-V was measured on a test sample generated with certain machine and tool parameters. Further improvement in surface finish may be possible by employing refined diamond turning procedure and equipment.

38431 Neutron scattering study of the nucleation and growth process at the pressure-induced first-order phase transformation of RbI. Hamaya, N.; Yamada, Y.; Axe, J.D.; Belanger, D.P.; Shapiro, S.M. (Faculty of Engineering Science, Osaka University, Toyonaka, Osaka 560, Japan). *Physical Review [Section] B: Condensed Matter;* **33**: No. 11, 7770-7776(1 Jun 1986). Contract AC02-76CH00016.

We have studied the kinetics of the NaCl-CsCl phase transformation in RbI at room temperature (P/sub c/apeq23.5 kbar) and at temperatures down to 200 K by monitoring the time-dependent changes in neutron powder diffraction peaks. Within the interval of temperature studied, the rate of growth of the stable phase increases as $\Delta P = |P - P/\text{sub } c/|$ is increased. The characteristic time of completion of transformation $t_0(P)$ at room temperature diverges as the pressure approaches P/sub c/ consistent with the form $\Delta P/\text{sup } -3/4/\exp[B(\Delta P)^{-2}]$, predicted by classical theory. At room temperature the observed growth curves for various pressures display a nearly universal shape, consistent with the Kolmogorov model of nucleation and growth, when plotted against a scaled time parameter $\text{tau} = t/t_0(P)$. At 240 K the growth curves deviate from the universal shape increasingly with increasing ΔP. Moreover, within a single growth curve the deviation becomes more evident in the later stage of growth. These observations can be explained qualitatively by taking into account the effect of stress produced by the volume change associated with the transformation.

38432 Deep inelastic neutron scattering from single-crystal hcp ^{4}He. Sokol, P.E.; Peek, D.A.; Simmons, R.O.; Price, D.L.; Hilleke, R.O. (Department of Physics, Harvard University, Cambridge, Massachusetts 02138; Department of Physics, University of Illinois, Urbana, Illinois 61801). *Physical Review [Section] B: Condensed Matter;* **33**: No. 11, 7787-7789(1 Jun 1986). Contract AC02-76ER01198;W-31-109-ENG-38.

The inelastic neutron scattering from a single crystal of hcp ^{4}He has been measured at high momentum transfer with Q oriented between the c axis and the basal plane. The width of the scattering function, which reflects the width of the single-particle momentum distribution, is found to be independent of scattering angle within experimental uncertainties.

38433 Neutron-diffraction evidence for ordering in the high-T/sub c/ phase of β-di[bis(ethylenedithio) tetrathiafulvalene]triiodide [β-$(ET)_2I_3$]. Schultz, A.J.; Beno, M.A.; Wang, H.H.; Williams, J.M. (Chemistry and Materials Science and Technology Divisions, Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review [Section] B: Condensed Matter;* **33**: No. 11, 7823-7826(1 Jun 1986). Contract W-31-109-ENG-38.

Satellite reflections, which are present in the neutron-diffraction pattern of β-di[bis(ethylenedithio)tetrathiafulvalene]triiodide [β-$(ET)_2I_3$] at ambient pressure below 200 K, are absent above a critical pressure of 0.5 kbar applied at room temperature and followed by cooling. The satellite reflections remain absent if the pressure is released while the temperature is maintained at 20 K. The absence of satellite reflections, and therefore the absence of a previously discovered modulated structure, indicates a higher degree of ordering in the high-pressure—high-T/sub c/ state in comparison to the ambient-pressure—low-T/sub c/ state of β-$(ET)_2I_3$. .AE

38434 Evidence of a magnetic gaplike excitation in URu_2Si_2. Walter, U.; Loong, C.; Loewenhaupt, M.; Schlabitz, W. (Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review [Section] B: Condensed Matter;* **33**: No. 11, 7875-7878(1 Jun 1986). Contract W-31-109-ENG-38.

We report the observation of a sharp gaplike magnetic excitation at low temperatues by inelastic neutron scattering in the heavy-fermion 5f system URu_2Si_2. At T = 10 K this sharp excitation occurs at an energy transfer of 5.5 meV and has a Lorentzian relaxational-type tail at higher-energy transfer. The gap rapidly disappears as the sample is heated and at T = 50 K the response function consists of only one quasielastic line. The Q dependence of the low-temperature peak suggests that antiferromagnetic correlations are important.

38435 Relative importance of surface and volume scattering in all-dielectric mirrors. (Battelle Pacific Northwest Laboratories, P.O. Box 999, Richland, Washington 99352). *Applied Optics;* **25**: No. 10, 1532-1533(15 May 1986). Contract AC06-76RL01830.

Total integrated scattering techniques are used to study power losses at 633 nm from bare and aluminized dielectric mirrors.(AIP)

38436 Method of using polysilane positive photoresist materials. Harrah, L.A.; Zeigler, J.M. (to Dept. of Energy, Washington, DC). US Patent 4,587,25. 6 May 1986. Filed date 5 Apr 1984. vp.

A method is described of photopatterning a positive image onto a substrate coated with polysilane, comprising irradiating the coated substrate with actinic radiation forming a pattern of the positive image on the substrate, whereby the portions of the polysilane coating on which the radiation impinges are photodepolymerized to form products which volatilize and whereby the substrate becomes uncoated in the pattern of the positive image.

38437 Self-transparency effects in heterogeneous nonlinear scattering media and their possible use in lasers. Al'tshuler, G.B.; Ermolaev, V.S.; Krylov, K.I.; Manenkov, A.A.; Prokhorov, A.M. (General Physics Institute of the USSR Academy of Sciences, Moscow, USSR). *Journal of the Optical Society of America B: Optical Physics;* **3**: No. 5, 660-667(May 1986).

Transmission of intense laser beams through heterogeneous scattering media is considered. Effects of intensity limitation, self-recovery of the wave front of a transmitted beam, and bistable reflection associated with the laser-induced self-transparency (suppression of scattering) of such media are predicted because of the compensation of the linear refractive-index difference $\Delta n/\text{sub } L/$ of the heterocomponents of a medium by nonlinear change $\Delta n/\text{sub } N//\text{sub } L/$ for different mechanisms of nonlinearity. Applications

of these effects in lasers for Q switching and mode locking are discussed. The observation of self-transparency effects in several heterogeneous media (glass particles in toluene and nitrobenzene, and lead molybdenite powder) for cw Ar- and pulsed Nd- and CO_2-laser radiation is reported. Q switching and mode locking have also been demonstrated with a YAG:Nd laser using nonlinear scattering in a heterogeneous cell as a control element in a laser resonator.

38438 Direct-laser writing of silicon microstructures: Raman microprobe diagnostics and modeling of the nucleation phase of deposition. Herman, I.P.; Magnotta, F.; Kotecki, D.E. (Department of Physics, University of California, Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 659-664(May 1986). Contract W-7405-ENG-48.

Two topics vital to the analysis and applications of direct-laser writing of silicon microstructures are addressed here: optical diagnostics and modeling. The use of real-time and postprocessing Raman microprobe analysis of laser-written doped polysilicon microstructures on CMOS gate arrays is shown to be a useful diagnostic tool. Also, the results of a Monte Carlo simulation of adatom migration and desorption are applied to the study of nucleation effects in direct-laser writing, with specific reference to the deposition of silicon.

38439 Growth, nucleation, and electrical properties of molecular beam epitaxially grown, As-doped Ge on Si substrates. Sheldon, P.; Yacobi, B.G.; Asher, S.E.; Jones, K.M.; Hafich, M.J.; Robinson, G.Y. (Solar Energy Research Institute, Golden, Colorado 80401). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 889-893(May 1986). Contract AC02-83CH10093.

Epitaxial Ge is grown on (100)Si substrates by molecular beam epitaxy (MBE). The effect of various MBE growth conditions on both the nucleation and morphology of Ge grown on Si is studied by Auger electron spectroscopy (AES), scanning electron microscopy (SEM), and reflection high-energy electron diffraction (RHEED). These studies indicate that, at the substrate temperatures examined (300—600 °C), heteroepitaxy of Ge on Si favors three-dimensional growth, which is enhanced by both higher growth temperatures and substrate preparation techniques that leave residual surface contamination. Heavily doped n^+ Ge layers are obtained using an elemental As source. The electrical properties of these films are evaluated by Hall—van der Pauw measurements. Growth temperatures of 250 °C and optimum As:Ge flux ratios yield electron concentrations as high as 2.5×10^{20} cm^{-3}. Secondary ion mass spectroscopy (SIMS) and Hall effect data show that for As concentrations which exceed this optimum level, a decrease in both the electron concentration and drift mobility is observed, indicating the presence of electrically inactive As.

38440 X-ray study of orientational epitaxy in rare gas monolayers on graphite. D'Amico, K.L.; Moncton, D.E. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1455-1458(May 1986). Contract AC02-76CH00016.

Rotating anode x-ray studies of Kr and Xe monolayers absorbed on the single crystal graphite(001) surface are described. Orientational epitaxy is observed for the Kr monolayer in agreement with previous electron diffraction studies. The Xe solid also displays a rotated phase at roughly-equal115 K. A comparison of the x-ray and electron diffraction techniques for structural studies of adsorbates on single crystals is made.

38441 Chemistry of hydrogen and arsenic interactions at silicon grain boundaries. Kazmerski, L.L. (Solar Energy Research Institute, Golden, Colorado 80401). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1638-1642(May 1986). Contract AC02-83CH10093.

The incorporation of hydrogen and arsenic in silicon grain boundaries is investigated. Volume-indexed SIMS and AES are utilized for the identification of impurity species (elemental or molecular), their concentrations (quantification), and their exact spatial location (mapping). The chemistry of the interaction of the hydrogen with the ion-modified Si surface and the grain boundary is investigated for both oxygen-deficient and oxygen-rich intergrain regions. Three bonding schemes are identified, including SiH_2, SiH, and SiOH. Thermal desorption studies complement the surface analytical investigations. Arsenic segregation to grain boundaries is directly demonstrated using high spatial and depth resolution volume-indexed AES. The effects of this segregation of the band structures of these grain boundaries are discussed.

38442 Metal-derived band gap states: Ti on GaAs(110). Ludeke, R.; Straub, D.; Himpsel, F.J.; Landgren, G. (IBM T.J. Watson Research Center, Yorktown Heights, New York 10598). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 874-878(May 1986).

The emergence of filled and empty Ti-derived interface states in the band gap of GaAs has been observed for coverages as low as 0.03 monolayer with synchrotron radiation excited photoemission (XPS) and inverse photoemission (IPS) spectroscopies. The onset of the photoelectron threshold for filled states in the valence band spectra and of the IPE photon threshold for the empty states follow directly the position of the surface Fermi level in the band gap. The origin of these states is associated with the rehybridization of the Ti-3d electrons with the valence electrons of the Ga and As atoms of the interface. This notion is supported by XPS core level studies, which show the occurrence of exchange reactions between the Ti and Ga, and the out-diffusion of As and its reaction with Ti. Chemical rebonding at the interface, which produces bonding (filled) and nonbonding (empty) states, is thus the first demonstrable mechanism for Fermi level pinning and Schottky barrier formation.

38443 Chemisorption of tritium on graphites at elevated temperatures. Strehlow, R.A. (Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1183-1185(May 1986). Contract AC05-84OR21400.

Tritium interactions with graphite will influence the design of procedures for handling graphite components. The tritium sorption capacities of various graphite grades are therefore needed. In a series of measurements, several graphite specimens in different states of oxidation were exposed to tritium gas and to tritium oxide at temperatures ranging from 175 to 750 °C. Higher temperatures were found to result in tritium sorption at concentrations as high as 2.1×10^{13} cm^{-2}. Sorbed quantities at lower temperatures after exposure to either tritium oxide or tritium gas were found to be in the range of 1×10^{9} cm^{-2}. Oxidized specimens showed the expected profile effects of greater penetration of the tritium into the specimens. The relationship of the BET surface area to the amount adsorbed appeared to be linear for oxidized specimens; however, the amount of tritium sorbed by unoxidized specimens could not be simply related to the BET surface area.

38444 Retention and thermal release of oxygen implanted in graphite. Wampler, W.R.; Brice, D.K. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1186-1188(May 1986). Contract AC04-76DP00789.

The retention of oxygen implanted in graphite at 1.5 and 3 keV was measured as a function of fluence. At fluences less than 10^{16} O/cm^2 the oxygen was all retained, but at higher fluences the retention saturated. Models describing the retention are discussed which include the effects of sputtering and a saturation limit to the local oxygen concentration. Thermal release of oxygen implanted to saturation at room temperature began at 250°C and was 90% complete by 750°C.

38445 Retention of deuterium and tritium in POCO AXF-5Q graphite. Causey, R.A.; Baskes, M.I.; Wilson, K.L. (Sandia National Laboratory, Livermore, California 94550). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1189-1192(May 1986).

The retention of 100 eV deuterium and tritium ions in POCO AXF-5Q graphite has been measured for the temperature range 323—1773 K. Both nuclear reaction analysis and dissolution counting were used. Below 1000 K, the retention is thought to be characterized by saturation of the near-surface region and by surface diffusion on internal porosity. Above 1000 K, the retention appears to be controlled by transgranular diffusion with decoration of high energy traps.

38446 **Auger analysis of Si—H bonding and hydrogen concentration in hydrogenated amorphous silicon.** Nelson, A.J.; Burnham, N.A.; Schwartzlander, A.B.; Asher, S.E.; Kazmerski, L.L. (Solar Energy Research Institute, Golden, Colorado 80401). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1570-1573(May 1986).

Auger electron spectroscopy line-shape analysis of the Si-L_{23} VV peak has been performed on hydrogenated amorphous silicon (a-Si:H). Both a-Si:H produced by hydrogen implantation of silicon single crystals (for analytical standards) and thin films (fabricated for solar cell applications) were examined in these studies. Hydrogen concentrations were confirmed by secondary ion mass spectrometry, and samples having hydrogen content over the range 10^{16}—10^{22} cm^{-3} were evaluated. Correlations between the area under the deconvoluted L_{23}VV transition peak and the known hydrogen content have resulted in a semiquantitative method of determining hydrogen concentration using Auger analysis. The percentage of the $L_{23}M_1M_{23}$ (sp) transition relative to the $L_{23}M_{23}M_{23}$ (pp) transition has been determined and also correlated with the hydrogen concentrations. These results have been compared with previously published theoretical calculations.

38447 **Raman spectroscopy of boron carbides and related boron-containing materials.** Shelnutt, J.A.; Morosin, B.; Emin, D.; Mullendore, A.; Slack, G.; Wood, C. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *AIP (American Institute of Physics) Conference Proceedings;* 140: No. 1, 312-324(15 Apr 1986). (CONF-850786—). Contract AC04-76DP00789.

From International conference on the physics and chemistry of boron and boron-rich borides; Albuquerque, NM, USA (29 Jul 1985).

Raman spectra of crystalline boron, boron carbide, boron arsenide ($B_{12}As_2$), and boron phosphide ($B_{12}P_2$) are reported. The spectra are compared with other boron-containing materials containing the boron icosahedron as a structural unit. The spectra exhibit similar features some of which correlate with the structure of the icosahedral units of the crystals. The highest Raman lines appear to be especially sensitive to the B-B distance in the polar triangle of the icosahedron. Such Raman structural markers are potentially useful in efforts to tailor electronic properties of these high temperature semiconductors and thermoelectrics.

38448 **Retention of deuterium and tritium in Papyex graphite.** Causey, R.A.; Wilson, K.L. (Sandia National Labs., Livermore, CA, USA). *Journal of Nuclear Materials;* 138: No. 1, 57-64(Mar 1986).

The retention of 100 eV D-T ions in Papyex graphite over the temperature range 373 to 1573 K has been measured using both nuclear reaction analysis and tritium dissolution counting. Below 1000 K, the retention is characterized by saturation of the near surface region and atomic adsorption on internal porosity, both of which decrease with increasing temperature. Above 1000 K, a local maximum in the retention is seen near 1200 K due to intergranular diffusion and decoration of high energy traps.

38449 **Applications of photoferroelectric properties of electrooptic ceramics.** Land, C.E. (Sandia National Labs., Albuquerque, NM 87185). pp 32 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

An intrinsic photoferroelectric effect can be used to store photographic images or other optical information in transparent, ferroelectric-or antiferroelectric-phase lead lanthanum zirconate titanate (PLZT) ceramics. The photosensitivity of this optical storage process has been increased by more than 10^4 by ion implantation or a combination of ion implantation and thermal diffusion in a surface of a thin PLZT plate. This increased photosensitivity enhances the feasibility of new devices for optical information processing and spatial light modulation using light beam addressing. This paper discusses the unique capabilities of electrooptic ceramics as erasable and reusable optical information storage devices. Surface modification techniques to further increase photosensitivity are examined in view of recent research results.

38450 **Study of possible solarization - related impurities in CaF_2 and other fluorides.** Edgett, L.B.; Stotlar, S.C. (Los Alamos National Lab., Materials Science and Tech. Div., Los Alamos, NM 87545). pp 134-139 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

CaF_2, MgF_2 and SrF_2 representative samples were obtained from three commercial single crystal sources. After repolishing their surfaces, all samples were subjected to spectographic quantitative chemical analysis, un-visible and infrared transmission spectrophotometry, and infared reflection spectrophotometry. A correlation of optical properties observed and trace impurities or dopants found by chemical analysis was observed, and details are presented.

38451 **Summary of recent studies on AlGaAs/GaAs radiation hardened photodiodes.** Wiczer, J.J. (Sandia National Labs., Microsensor Div. 1142, Albuquerque, NM 87185). pp 168-170 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

In this paper, the authors summarize the results of several studies assessing the radiation hardness of a new type of double heterojunction, AlGaAs/GaAs photodiode. These studies include transient and permanent damage experiments. Transient studies indicate that double heterostructure AlGaAs/GaAs photodiodes generate 40 times less photocurrent than conventional silicon photodiodes during exposures to ionizing-radiation pulses. Permanent damage studies with neutrons, Co^{60} gamma rays, and high energy electron beam sources indicate only minor changes in operational characteristics after exposure. These studies have shown a 20% degradation in optical response and a factor of 8 increase in photodiode leakage current after exposure to 3.6 x 10^{15} neutron/cm^2 fluence. Conventional silicon photodiodes exhibit this type of degradation after exposure to 10^{12} - 10^{13} neutrons/cm^2 fluences. These characteristics are important for many specialized applications requiring radiation hardness.

38452 **Laser-induced photochemical dry etching of III-V compound semiconductors.** Ashby, C.I.H. (Laser and Atomic Physics Div. 1126, Sandia National Labs., Albuquerque, NM 87185). pp 467-471 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

There is a great need for anisotropy and selectivity in dry etching processes used for III-V semiconductor device fabrication. We have developed a laser-induced photochemical dry etching process which can provide both anisotropy without ion-induced lattice damage and a level of material and dopant selectivity unattainable with current plasma etching processes. Low intensity light with photon energy greater than the band gap of the material drives the photochemical process through photogeneration of electrons and holes. The requirement of photons with energy greater than or equal to the band gap permits total selectivity between materials of different band gaps, such as GaAs and GaP. The voltage-dependent behavior of the photogenerated carrier permits selective

etching of p-GaAs versus n-GaAs and selectivity among n-GaAs materials with different doping levels.

38453 **Very high strength cement-based materials.** Young, J.F. Pittsburgh, PA; Materials Research Society (1985). 317p. (CONF-841157—). Materials Research Society, 9800 McKnight Road, Suite 327, Pittsburgh, PA 15237.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

These proceedings present 28 papers arranged under the following headings: 1.) Microstructure and fracture; 2.) Pore structure and its effect on properties; 3.) Properties and mix design for structural applications; 4.) Novel nonstructural applications.

38454 **Natural convection heat transfer in porous media.** Catton, I. (Mechanical, Aerospace, and Nuclear Engineering, Univ. of California, Los Angeles, CA). pp 514-547 of Natural convection: Fundamentals and applications. Kakac, S.; Aung, W.; Viskanta, R. New York, NY; Hemisphere Publishing (1985).

The results of three studies are reported in this paper. A power integral solution was developed for superposed layers (a fluid layer over a saturated porous media). Heat transfer results for various values of the Darcy number, fluid to solid thermal conductivity ratio and fluid to porous media height ratio are given as a function of a combined Rayleigh number. A single saturated porous media layer was studied experimentally and analytically. Both experiment and analysis are used to demonstrate that excessive scatter in reported data are due to not including the effect of the product of Prandtl number and Karman-Cozeny number. Analysis are shown to require the inertial terms to account for this effect. A potential closure hypothesis for the preferred wavenumber question was explored and found to show promise.

38455 **Sensitive detection of tunable diode laser absorption by polarization rotation.** Loge, G.W.; Laguana, G.A.; Hartford, A. (Los Alamos National Laboratory, Los Alamos, NM 87545). pp 376-380 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

Results are presented demonstrating that diode laser absorption sensitivity can be increased by using the Faraday or Kerr effect to rotate the polarization of the source so that crossed polarizers can be used to reduce source noise. The Faraday effect is demonstrated using nitric oxide in a magnetic field, and the Kerr effect is demonstrated using methyl fluoride in an electric field. Some description of how absorption in an external field causes polarization rotation is presented as well as some conclusions on the types of molecules for which this technique is best suited.

38456 **Intervalence-band absorption saturation and optically induced damage of GaAs by pulsed CO_2 laser radiation.** James, R.B.; Christie, W.H.; Eby, R.E.; Darken, L.S. Jr.; Mills, B.E. (Sandia National Labs., Livermore, CA 94550). pp 435-444 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The absorption of CO_2 laser radiation in p-type GaAs is is dominated by direct free-hole transitions between states in the heavy- and light-hole bands. For laser intensities on the order of 10 MW/cm^2, the absorption associated with these transitions in moderately Zn-doped GaAs begins to saturate in a manner predicted by an inhomogeneously broadened two-level mode. For heavily Zn-doped samples ($\geq 10^{18}$ cm^{-3}), large areas of the surface are found to melt at comparable laser energy densities, in contrast to the lightly doped samples in which the damage initially occurs in small localized sites. As the energy density of the CO_2 laser radiation is progressively increased, the surface topography of the samples shows signs of ripple patterns, high local stress, vaporization of material, and exfoliation of solid GaAs fragments. X-ray emission data taken on the laser-melted samples show that there is a loss of As, compared to Ga, from the surface during the high temperature cycling. Secondary ion mass spectrometry (SIMS) measurements are used to study the diffusion of oxygen from the native oxide and the incorporation of trapped oxygen in the near-surface region of the GaAs samples that have been melted by a CO_2 laser pulse. The authors find that oxygen trapping does occur, and that the amount and depth of the oxygen signal depends on the laser energy density and number of laser shots.

38457 **Nuclear-radiation-induced absorption in optical materials.** Brannon, P.J.; Morris, R.W.; Gerardo, J.B. (Sandia National Labs., Albuquerque, NM 87185). pp 451-459 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

Reactor radiation-induced transient absorption was measured in 7940 fused silica, magnesium fluoride, barium fluoride and sapphire at 257 nm. The fused silica gave the lowest induced transient absorption of all the materials studies. The absorption coefficient per unit dose for fused silica (1.5 cm^{-1}/Mrad) was much more than the value given previously in the literature. The previously measured value was at a temperature of 500°C, suggesting that the induced transient absorption can be greatly reduced by elevating the temperature of the sample. The absorption coefficient per unit dose was also found to be dose rate dependent.

38458 **Raman studies of laser damaged single- and multilayer optical coatings.** Exarhos, G.J.; Morse, P.L. (Battelle Pacific Northwest Lab., Richland, WA 99352). pp 460-466 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

Structural changes in dielectric optical coatings induced thermally or by high energy pulsed laser irradiation have been studied by the non-destructive technique of Raman Spectroscopy. A two laser damage, probe) arrangement was used to characterize the damage process in crystalline and amorphous TiO_2 and ZrO_2 coatings on silica during irradiation and at longer times following the onset of damage. Raman measurements were also undertaken to assess the effects of coating phase and microcrystalline grain orientation on laser induced damage in TiO_2. Results suggest that certain phases have higher damage thresholds for comparable coating thicknesses and that thermal and electronic excitation effects are important considerations for modeling the damage process.

38459 **Comparison of ion-milling techniques for cross-sectional TEM of semiconductors.** Luck, J.T.; Boggs, C.W.; Pennycook, S.J. (Oak Ridge National Lab., TN). *Proceedings - Annual Meeting, Electron Microsopy Society of America;* 43: 166-167(1985). Contract AC05-84OR21400.

The use of cross-sectional Transmission Electron Microscopy (TEM) has become invaluable for the characterization of the near-surface regions of semiconductors following ion-implantation and/or transient thermal processing. A fast and reliable technique is required which produces a large thin region while preserving the original sample surface. New analytical techniques, particularly the direct imaging of dopant distributions, also require good thickness uniformity. Two methods of ion milling are commonly used, and are compared below. The older method involves milling with a single gun from each side in turn, whereas a newer method uses two guns to mill from both sides simultaneously. 4 references, 3 figures.

38460 **Study of the mechanism for annealing embrittlement of an iron-based metallic glass.** Kroeger, D.M.; Koch, C.C.; McKamey, C.G.; Scarbrough, J.O.; Padgett, R.A. (Oak Ridge National Lab., TN). pp 1369-1372 of Rapidly quenched metals. Steeb, S.; Warlimont, H. (eds.). Amsterdam, Netherlands; Elsevier Science Publishers B.V. (1985). Contract AC05-84OR21400.

Fracture surfaces of annealed and embrittled $Fe_{80}B_{16}Si_3C_2$ melt-spun ribbons were examined by Auger electron spectroscopy. Evidence was found that inhomogeneous distributions of oxygen and of alloy constituents may be involved in embrittlement. It was found that micro-additions of cerium to the alloy decreased the rate of embrittlement.

38461 **Atomic structure of Si-SiO_2 interfaces suggesting a ledge mechanism of silicon oxidation.** Mazur, J.; Washburn, J. (Materials and Molecular Research Division Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720). *AIP (American Institute of Physics) Conference Proceedings;* **122**: No. 1, 52-55(1 Nov 1984). (CONF-8408104—). Contract AC03-76SF00098.

From Conference on the physics of very large scale integration (VLSI); Palo Alto, CA, USA (1 Aug 1984).

The atomic structure of Si-SiO_2 interfaces resulting from oxidation of singular {111} and vicinal (111)3°[11{0] and (111)2°[11{2] has been studied by high resolution electron microscopy. The transition from crystalline Si to amorphous SiO_2 was found to be very abrupt. The structure of the interface can be described by a terrace-ledge-kink-model. This structure is consistent with a ledge mechanism of silicon oxidation.

38462 **Zone-melting recrystallization of thick silicon on insulator films.** Atwater, H.A.; Smith, H.I.; Thompson, C.V.; Geis, M.W. (Massachusetts Institute of Technology, Cambridge). *Materials Letters;* **2**: No. 4A, 269-273(Mar 1984).

The authors report unseeded zone-melting recrystallization of encapsulated Si films, up to 60 μm thick, on SiO_2. The crystallographic texture of the films changes from (100) to random as the thickness is increased beyond 5 μm. The subboundary spacing increases with film thickness, and two regimes of thickness dependence are observed. The authors report a vertical-constriction patterning technique which enables a uniform (100) texture to be achieved in thick films. 17 references, 5 figures.

38463 **Mathematical description of transient crack growth behavior in glass.** Ferber, M.K. (Oak Ridge National Lab., TN). *Journal of Materials Science;* **19**: 2570-2574(1984). Contract W-7405-ENG-26.

Transient crack growth behavior resulting from time-dependent changes in crack-tip radium can occur near the fatigue limit. In the present work, mathematical expressions describing this transient behavior are developed assuming that a dissolution reaction is responsible for changes in crack geometry. An elliptical crack is analyzed because of its mathematical simplicity. The theoretical model slightly underestimates the extent of crack-tip blunting occurring below the fatigue limit. However, the predicted transient behavior associated with the crack-tip sharpening processes which take place above the fatigue limit compares favorably with experimental data for glass. 18 references, 3 figures, 2 tables.

38464 **Advances in the measurement of ambient carbon fibers.** Loo, B.W.; Adler, T.C.; Goulding, F.S.; Landis, D.A.; Madden, N.W. (Lawrence Berkeley Lab., CA). *Aerosol Science and Technology;* **3**: 31-38(1984). Contract AC03-76SF00098.

The authors briefly summarize various methodologies that have been used in a number of passive collectors and active detectors for measuring ambient carbon fibers. The need for improved performance in terms of specificity, sensitivity, detection efficiency, accuracy, precision, speed, stability, and serviceability are identified. The design principles for a new detector based on the technique of measuring the induced charge acquired by a conducting fiber in an electric field are discussed in detail. A prototype of such a detector has been tested to cover the measurement of fiber length distributions between 0.08 and 9 mm and fiber concentrations between 1 and 10_8 fibers/m^3 of air. The precision of this instrument has been demonstrated to be about 2% for fibers in the 1-9-mm range and to approach one fiber diameter (or 10μm) for the submillimeter fibers. 15 references, 2 figures, 1 table.

38465 **Low temperature (150-250°C) deposition of n^+ and p^+ microcrystalline silicon for VLSI device contacts.** Rajeswaran, G.; Vanier, P.E.; Kampas, F.J.; Corderman, R.R. (Brookhaven National Lab., Upton). *Materials Research Society Symposia Proceedings;* **25**: 563-568(1984). Contract AC02-76CH00016.

The rf glow discharge decomposition of dilute mixtures (~1%) of SiH_4 in H_2, with suitable doping agents such as PH_3 or B_2H_6 added, produces n^+ and p^+ microcrystalline (μc) silicon films with resistivities (Rho) in the 10^{-1} ω cm range at exceedingly low substrate temperatures T/sub s/ (150-250°C). The μc-Si films consist of two phases with crystalline clusters embedded in an amorphous matrix. The films are stable when temperature-cycled in the 30-400°C range and the resistivity decreases when annealed above the original deposition temperature. A model of microcrystalline film growth involving the reactions between the gas phase radicals and the growing film surface is proposed. 11 references, 4 figures, 1 table.

38466 **Structure of orange $^{18}O_2$ at 9.6 GPa and 297 K.** Schiferl, D.; Cromer, D.T.; Schwalbe, L.A.; Mills, R.L. (Los Alamos National Lab., NM). *Acta Crystallographica, Section B: Structural Crystallography and Crystal Chemistry;* **B39**: 153-157(1983).

A single crystal of orange $^{18}O_2$ at 9.6 (3) GPa and 297 (1) K was produced in a Merrill-Bassett diamond-anvil high-pressure cell and examined by X-ray diffraction. Pressure was determined with the ruby-fluorescence method. The unit cell is orthorhombic, space group Fmmm, lattice constants a = 4.2151 (6), b = 2.9567 (4), c = 6.6897 (17) A, molar volume = 12.56 x 10^{-6} m^3 mol^{-1} with four molecules per unit cell. The charge densities of the molecules overlap or distort to a considerable degree. Generalized scattering factors were used in an aspherical-atom least-squares refinement. For five refined parameters and 24 observations the final R/sub w/ is 0.056. A correction is made to our previous work on β-O_2 at 5.5 GPa and 299 K.

38467 **Absorption measurements at high pressure (0-10 kbar) on strained superlattices.** Gavrilovic, P.; Meehan, K.; Holonyak, N. Jr.; Hess, K.; Zurawsky, W.P.; Drickamer, H.G.; Ludowise, M.J.; Dietze, W.T.; Lewis, C.R. (Univ of Illinois, Urbana-Champaign). *Solid State Communications;* **45**: No. 9, 803-806(1983). Contract AC02-76ER01198.

Absorption data on strained GaAs/sub 1-x/P/sub x/-GaSa superlattices (SL, 128-period, barrier size L/sub B/~ 75 A, quantum-well size L/sub z/~ 75 A, alloy composition x ~ 0.25) are presented in the range 0-10 kbars. The absorption curves obtained show no exciton peaks such as seen in lattice-matched Al/sub x/Ga/sub 1-x/As-GaAs SL's, and the pressure coefficient decreases from 11.5 MeV/kbar to ~ 10.5 MeV/kbar in the wells and ~ 6.5 MeV/kbar at energies approaching and above the barrier energies. This behavior is attributed to the fluctuations in strain caused by the alloy disorder, and clustering, of the barriers. 12 references, 3 figures.

38468 **Photocurrent spectroscopy of a strained-layer superlattice.** Fritz, I.J.; Biefeld, R.M.; Osbourn, G.C. (Sandia National Labs., Albuquerque, NM). *Solid State Communications;* **45**: No. 4, 323-325(1983). Contract AC04-76DP00789.

Strained-layer superlattices (SLS's) are a new kind of semiconductor material, grown from lattice-mismatched constituents, whose electronic properties may be tailored over a wide range. The authors report the growth by metal-organic chemical vapor deposition of a GaAs/sub 0.4/P/sub 0.6//GaP SLS, and the characterization of its room temperature electronic properties by photocurrent spectroscopy. The results are consistent with predictions of an effective-mass (Kronig-Penney) model. 8 references, 3 figures.

38469 **Channeling radiation: atomic and molecular physics in one and two dimensions.** Datz, S. (Oak Ridge National Lab., TN). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 723-733(1982). (CONF-820855—). Contract W-7405-ENG-26.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

Energetic electrons entering a crystal in low index planar directions can be trapped into bound states of the potential made up by the atoms in the planar sheet. This potential has associated eigenstates analogous to an averaged one dimensional atom. Similarly electrons injected in an axial direction are bound into eigenstates of the two dimensional string potential characterized by two quantum numbers n,l. In some crystal directions (e.g., diamond <110>) two strings lie in close proximity and their potentials overlap so that binding to both strings occurs and two dimensional molecular levels obtained. When positrons are injected in planar directions they are bound between the atomic sheets into an almost harmonic potential. In compound crystals the potential can become more complex. Radiation arising from bound state transitions in all the above configurations has been observed (Ee^- = 4-54 MeV, Ee^+ = 28-54 MeV, E/sub h nu/ = 4-150 keV) in a number of materials (C, Si, Ge, LiF). Information concerning atomic potentials and valence electron densities has been obtained and is discussed. 18 references, 8 figures.

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REFER ALSO TO CITATION(S) 37288, 37288, 37298, 37331, 37507, 37507, 37620, 37651, 37707, 38305, 38305, 38334, 38407, 38450, 38456, 38456, 38518, 38742, 38758, 38906, 38923

38470 (IS-T—1227) Evaluation of a direct injection nebulizer interface for flow injection analysis and high performance liquid chromatography with inductively coupled plasma-atomic emission spectroscopic detection. LaFreniere, K.E. (Ames Lab., IA (USA)). Jun 1986. Contract W-7405-ENG-82. 206p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE86012671.

A direct injection nebulizer (DIN) was designed, developed, and evaluated to determine its potential utilization as an effective interface for flow injection analysis (FIA) and high performance liquid chromatography (HPLC) coupled with inductively coupled plasma-atomic emission spectroscopic detection. The analytical figures of merit for the DIN when used as an interface for FIA-ICP-AES were found to be comparable to or better than those obtained with conventional pneumatic nebulization in terms of limits of detection (LODs), reproducibility, linearity, and interelement effects. Stable plasma operation was maintained for the DIN sample introduction of a variety of pure organic solvents, including acetonitrile, methanol, methylisobutylketone, and pyridine. The HPLC-DIN-ICP-AES facility was specifically applied for the speciation of inorganic and organometallic species contained in synthetic mixtures, vanilla extracts, and a variety of energy-related materials, such as shale oil process water, coal extracts, shale oil, crude oil, and an SRC II. Suggestions for future research are also considered. 227 refs., 44 figs., 15 tabs.

38471 (LA-UR—86-2220) Assay of TRU wastes containing (α,n) sources. Moss, C.E.; Caldwell, J.T. (Los Alamos National Lab., NM (USA)). Jun 1986. Contract W-7405-ENG-36. 7p. (CONF-860654—26). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012430.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

We have studied methods of determining alpha activity in transuranic waste from the gamma rays produced by the reactions (α,nγ), (α,pγ), and (α,$\alpha'\gamma$) or produced directly by the alpha-emitting isotopes. Gamma-ray spectra were acquired for 20 drums of waste at the Stored Waste Examination Pilot Plant at Idaho National Engineering Laboratory with a high-purity germanium detector. To assist in the analysis, gamma-ray spectra were also acquired from the following standard neutron sources: ^{238}Pu/Li, ^{241}Am/Li, ^{241}Am/Be, ^{241}Am/B, ^{241}Am/^{13}C, $^{238}PuO_2$, and ^{241}AmF. Neutron measurements on the 20 drums were made in a combined passive and active neutron assay system for transuranic waste in Idaho. Representative gamma-ray spectra, line intensities, and calculated alpha activities for the drums are presented. In most matrix types, the alpha activity can be estimated from the neutron assay system results alone or from the reaction gamma-ray outputs. This work demonstrates a method of certifying the alpha activity, as well as the fissile content, of transuranic waste for the Waste Isolation Pilot Plant.

38472 (PNL-SA—13584) Correlation of solvatochromic effects with retention in supercritical fluid chromatography. Yonker, C.R.; Gale, R.W.; Smith, R.D. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 20p. (CONF-8605132—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012150.

From 10. international symposium on column liquid chromatography; San Francisco, CA, USA (18 May 1986).

The study of mobile phase intermolecular interactions is reported using the solvatochromic technique for supercritical fluid chromatography (SFC). The change in the solvation character of the cybotactic region of the selected solute probes was observed to be dependent on the density of the solvent. This change in solvation is compared with solute retention under similiar pressure and temperature conditions for capillary SFC. The major solute-solvent interactions with CO_2 seems to be from dipole-induced dipole interactions. 25 refs., 8 figs.

38473 (SAND—86-1032C) Potential applications of artificially structured materials for x-ray microanalysis. Romig, A.D. Jr. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 17p. (CONF-860829—25). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010459.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

These materials are artifically structured on the atomic scale and exhibit properties uniquely different than those found in naturally occurring or conventionally processed materials. Recent advances in high vacuum deposition techniques have made these materials possible, since the manufacture of ASMs requires very clean environments and the capability to deposit layers with thicknesses ranging from fractions of a nm to a few nm. ASMs have been made from semiconductors, metals, metal-semiconductor combinations and metal-nonmetal combinations. The ASMs produced by layering high atomic number (Z) metals and low Z nonmetals or metals have unique x-ray interaction properties in that they can be used to produce normal incidence x-ray mirrors. It is the objective of this paper to review this new class of materials, with special emphasis on the high Z/low Z multilayer materials, describe applications for these materials currently in use for microanalysis and suggest future applications which should be considered by the x-ray microanalysis community.

38474 Atmospheric pressure helium afterglow discharge detector for gas chromatography. Rice, G.; D'Silva, A.; Fassel, V.A. (to Dept. of Energy, Washington, DC). US Patent 4,586,368. 6 May 1986. Filed date 5 Apr 1985. vp.

An electrodeless discharge apparatus is described for use in producing atmospheric pressure afterglows from helium as an element specific, multielemental gas chromatography detector comprising: a discharge tube having an upper open end, and a lower end means for supplying helium at atmospheric pressure to the discharge tube, a first electrode concentrically encircling at least a portion of the tube near the upper end and coupled to a suitable high frequency power source for applying power at a predetermined frequency to excite the helium, a second grounded electrode positioned coaxially with the upper open end of the tube, but spaced therefrom, for creating an afterglow region in the tube between the two electrodes and, sample discharge means for depositing a sample from the gas chromatograph into the afterglow region.

38475 A ranking tool for potentially carcinogenic polynuclear aromatic compounds in synfuel products. Vo-Dinh, T. (Advanced Monitoring Development Group, Health and Safety Research Div., Oak Ridge National Lab., Oak Ridge, TN). *American Chemical Society, Division of Gas and Fuel Chemistry, Preprints;* 31: No. 2, 183-188(Apr 1986). (CONF-860425—). Contract AC05-84OR21400.

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

This paper describes the use of a screening procedure to rank the content of polynuclear aromatic (PNA) species in synfuel samples. The ranking procedure is based on a cost-effectvie and rapid screening technique based on synchronous luminescence spectroscopy. The use of the screening procedure as a basis for screening of complex mixtures is discussed.

38476 **In situ Raman spectroscopy of anodic films formed on copper and silver in sodium hydroxide solution.** Hamilton, J.C.; Farmer, J.C.; Anderson, R.J. (Sandia National Labs., Livermore, CA 94550). *Journal of the Electrochemical Society;* 133: No. 4, 739-745(Apr 1986). Contract AC04-76DP00789.

In situ Raman spectroscopy and cyclic voltammetry have been used simultaneously to study anodic film growth and dissolution on Cu and Ag in strongly alkaline solution. On copper, Cu_2O and another species, believed to be a hydroxide, were detected spectroscopically during anodic film formation. Raman spectra of electrochemically formed hydroxides on copper have not previously been reported. On silver, AgO was detected. Neither CuO nor Ag_2O was observed by Raman spectroscopy, although for certain potentials. AgO was apparently produced by photochemical conversion of Ag_2O. Experiments were performed using both the 488 nm line from an argon laser and the 647.1 nm line from a krypton laser. It was concluded that the detection of these thin film oxides was by spontaneous or resonant Raman scattering and did not involve surface enhanced Raman scattering (SERS).

38477 **Far-infrared spectroscopy in diamond anvil cells.** Challener, W.A.; Thompson, J.D. (Center for Materials Science and Physics Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Applied Spectroscopy;* 40: No. 3, 298-303(Mar 1986).

A step-and-integrate Fourier transform spectrometer, a liquid-helium-cooled composite germanium bolometer, and specially configured nonfocusing optics have been interfaced to gasketed diamond anvil cells. Simple molecular solids like iodine have been studied at pressures up to 16 GPa, frequencies down to 20 cm^{-1}, and temperatures of 2 to 150 K with this arrangement. Evidence that spectroscopy in diamond anvil cells should be feasible to even lower frequencies and higher pressures is presented.

38478 **Nondestructive assay of uranium in infinitely-thick material.** Hagenauer, R.C. (Department of Energy, Argonne, IL, USA. New Brunswick Lab.). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* 242: No. 3, 574-576(15 Jan 1986). (CONF-850533—).

From 6. symposium on X- and gamma-ray sources and applications; Ann Arbor, MI, USA (21 May 1985).

A new nondestructive technique has been developed to permit the assay of uranium in nuclear material that is 'infinitely-thick' with respect to the 185.7-keV gamma ray. This new method not only provides a way of analyzing material that previously could not be analyzed, but also removes the requirement for geometry and self-absorption corrections. Assays, in g U/g, are determined using the ratio of the 98.4-keV uranium X rays generated from fluorescence activity to the 185.7-keV gamma ray from ^{235}U. Enrichment values needed for the assay calculation can be nondestructively determined from the same spectrum if they are not known. The weight of the sample can then be used to obtain absolute quantities. In material containing large amounts of uranium the mass absorption coefficients for the ^{235}U gamma ray and uranium X ray are nearly the same. Thus, no self absorption corrections are necessary. A number of different uranium materials in a variety of configurations were analyzed with an average difference of 6% between accepted and measured results.

38479 **Microanalytical techniques for boron analysis using the 10B(n,alpha)7Li reaction.** Fairchild, R.G.; Gabel, D.; Laster, B.H.; Greenberg, D.; Kiszenick, W.; Micca, P.L. (Brookhaven National Lab., Upton, NY). *Medical Physics;* No. 1, 50-6(Jan 1986).

In order to predict the efficacy of boronated compounds for neutron capture therapy (NCT), it is mandatory that the boron concentration in tissues be known. Various techniques for measurement of trace amounts of boron (1-100 ppm) are available, including chemical and physical procedures. Experience has shown that, with the polyhedral boranes and carboranes in particular, the usual colorimetric and spark emission spectroscopic methods are not reliable. Although these compounds may be traced with additional radiolabels, direct physical detection of boron by nondestructive methods is clearly preferable. Boron analysis via detection of the prompt-gamma ray from the 10B(n, alpha)7Li reaction has been shown to be a reliable technique. Two prompt-gamma facilities developed at Brookhaven National Laboratory are described. One, at the 60-MW high flux beam reactor, uses sophisticated beam extraction techniques to enhance thermal neutron intensity and reduce fast neutron and gamma contamination. The other was constructed at Brookhaven's 5-MW medical research reactor and uses conventional shielding and electronics to provide an on-line boron analysis facility adjacent to beams designed for NCT, thus satisfying one of the requisites for clinical application of this procedure. Technical restrictions attendant upon the synthesis and testing of boronated biomolecules often require the measurement of trace amounts of boron in extremely small (mg) samples. A track-etching technique capable of detecting ng amounts of boron in mg liquid or cell samples is described. Thus it is possible to measure the boron content in small amounts (mg samples) of antibodies, or boron uptake in cells grown in tissue culture.

38480 **Quantitative species concentration measurements using coherent anti-Stokes Raman spectroscopy with nonresonant susceptibility normalization.** Farrow, R.L.; Lucht, R.P.; Clark, G.L.; Palmer, R.E. (Sandia National Labs., Combustion Research Facility, Livermore, CA). pp 48 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The nonlinear nature of coherent anti-Stokes Raman spectroscopy (CARS) leads to drift and shot-to-shot variations in signal strength making quantitative concentration measurements difficult. The authors report CARS measurements using polarization analysis to separate the anti-Stookes signal into predominantly Raman (resonant) and electronic (nonresonant) components for subsequent independent detection. The ratio of these signals is concentration and temperature sensitive while being relatively insensitive to overall CARS signal fluctuations and drift. This approach provides superior accuracy and signal-to-noise enhancement for narrowband CARS measurements in comparison with other referencing schemes. Concentration results for CO, N_2, and H_2 in a rich CH_4/air flat flame are reported and compared with results from other techniques.

38481 **Two-step saturated fluorescence spectroscopy and imaging of atomic hydrogen in flames.** Goldsmith, J.E. (Sandia National Labs., Combustion Research Facility, Livermore, CA). pp 50 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

This paper describes a new two-step saturated flourescence technique that significantly extends the number of atomic and molecular species to which saturated fluorescence can be applied. A major advantage of this method is that easily obtained laser wavelengths in the visible can be used to saturate appropriate transitions, even for species in which the most readily accessible (i.e., longest-wavelength) optical transition falls in the VUV. For example, optical detection of hydrogen atoms is difficult in any environment because of the 10-eV gap between the ground state and the first excited state. Since Lyman-α(122-nm) radiation is strongly absorbed by flame gases and the surrounding air, optical detection of hydrogen in flames has relied on multiphoton excitation followed by either optogalvanic or fluorescence detection. The two-step fluorescence method described in this paper provides new capabilities for detecting atomic hydrogen and other species and has been used for the first demonstration of imaging of atomic hydrogen.

38482 MPI spectroscopy of NH_3: Application to rotational energy accommodation on surfaces. Kay, B.D.; Grimley, A.J.; Raymond, T.D. pp 330-338 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—). Contract AC04-76DP00789.

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

An ultra-sensitive ($> 10^6$ cm $^{-3}$/state) multiphoton ionization (MPI) spectroscopy for NH_3 has been developed. This technique employs two-photon resonant, three photon ionization. Symmetry constraints on the two-photon absorption enable the ground state inversion doublets to be easily resolved using conventional pulsed lasers. Computer simulations based on two-photon line strength factors and ground state rotational population distributions yield quantitative agreement with the observed spectra. Using this spectroscopy we have made the first measurement of rotational energy accommodation of a non-linear polyatomic molecule scattered from a surface. For NH_3 scattered from polycrystalline tungsten, the scattering is dominated by trapping-desorption resulting in a high degree of rotational accommodation.

38483 Ionization detection of stimulated Raman spectra. Esherick, P.; Owyoung, A. (Sandia National Labs., Div. 1124, Albuquerque, NM 87185). pp 356-361 of Southwest conference on optics. SPIE volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

Ionization-detected stimulated-Raman spectroscopy (IDSRS) is a new technique for high-sensitivity, high-resolution Raman studies. The technique is based on resonant laser ionization detection of vibrationally-excited molecules produced via stimulated Raman pumping. In this paper the authors illustrate the sensitivity of IDSRS relative to stimulated Raman gain spectroscopy by comparing spectra taken of the diatomic molecule NO using each technique. They then present more recent results on the application of IDSRS to a considerably larger molecule, benzene. These spectra, taken near 1600 cm^{-1}, cover the region where the ν^{16} fundamental and $\nu^2+\nu 18$ combination band of benzene overlap to produce a particularly complex appearing spectrum. By taking advantage of the double-resonance capabilities of IDSRS, they are to cleanly separate the contributions of each vibrational band and thereby greatly simplify their spectra.

38484 Laser measurements technique - laser spectroscopy in semiconductors. Jones, E.D.; Wickstrom, G.L. (Sandia National Laboratories, Albuquerque, NM 87185). pp 362-367 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—). Contract AC04-76DP00789.

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

A CAMAC-based digital data acquisition system to study luminescence spectra and dynamics in semiconductors using pulsed and cw laser sources is described. Various experimental techniques for measuring time-dependent luminescence and laser excitation spectra are discussed. In order to demonstrate the system performance and sensitivity of this data acquisition system, experimental low-temperature laser-induced luminescence data for the oxygen-bound exciton in the II-VI semiconductor compound ZnTe is presented.

38485 Application of Pattern Recognition to the analysis of metal ion chemical ionization mass spectra. Forbes, R.A.; Tews, E.C.; Freiser, B.S.; Wise, M.B.; Perone, S.P. (Chemistry Dept., Purdue Univ.). pp 891-892 of Proceedings of the 33rd annual conference on mass spectrometry and allied topics. East Lansing, MI; American Society for Mass Spectrometry (1985). (CONF-8505123—). Contract AC02-80ER10689.

From ASMS annual conference on mass spectrometry and applied topics; San Diego, CA, USA (26 May 1985).

The first application of Pattern Recognition to analyze metal ion chemical ionization data is described. These data were obtained using both a conventional ion cyclotron resonance (ICR) spectrometer, and a Fourier transform mass spectrometer (FTMS) equipped with laser ionization sources. The pattern recognition computations were performed using an IBM 9000 laboratory computer. Transition metal ions hold promise as selective chemical ionization reagents, since it is possible to select a wide variety of metals with varying reactivities. In this study pattern recognition is used as an objective means to evaluate the selectivities of two metal ions, Fe^+ and Y^+, towards six classes of organics and three subclasses of alkanes. Extraction of important chemical information by feature selection and inference of selectivity from misclassifications and recognition accuracies is shown.

38486 Secondary ion mass spectrometry of Lewis acids. Leibman, C.P.; Todd, P.J. (Univ. of Tennessee, Knoxville, TN). pp 170-171 of Proceedings of the 33rd annual conference on mass spectrometry and allied topics. East Lansing, MI; American Society for Mass Spectrometry (1985). (CONF-8505123—). Contract AC05-84OR21400.

From ASMS annual conference on mass spectrometry and applied topics; San Diego, CA, USA (26 May 1985).

Lewis acids have been extensively studied by using gas phase electron impact (EI) mass spectrometer The secondary ion mass spectrometry, (SIMS) of Lewis acids was investigated. In particular, SIMS spectra of various Group IIB, IIIB, IVB, VB, and VIB chlorides were obtained. Surprisingly, these spectra bear little resemblence to their EI counterparts. In particular, the molecular ion, M^+, is almost never observed in SIMS spectra of Lewis acids, while it is generally a dominant peak in corresponding EI mass spectra. Secondly, in almost all cases studied, the base peak in the SIMS spectrum of a Lewis acid corresponds to the singly charged metal ion. In fact, a good correlation can be obtained between the relative intensity of the metal ion and the electronegativity of the metal: the lower the electronegativity, the more intense will be the relative intensity of the secondary metal ion. For example, from an $AlCl_3$ sample, the Al^+ intensity is approximately 100 times that of the $AlCl^+$ ion, while from an $SbCl_3$ sample, the intensity of the secondary Sb^+ peak is approximately equal to the intensity of the $SbCl^+$ ion. In general, these results are consistent with other inorganic SIMS studies, but it is clear that the ionic character of whatever Lewis acid is studied is far more important to the secondary ion emission of the central metal ion than is the gas phase ionization energy of the metal.

38487 Mass spectrometric and chemiluminescent studies of CS_2i in a flowing argon afterglow. Shul, R.J.; Upschulte, B.L.; Passarella, R.; Leuchtner, R.E.; Keesee, R.G.; Castleman, A.W. (Dept. of Chemistry, Pennsylvania State University, University Park, PA). pp 146-147 of Proceedings of the 33rd annual conference on mass spectrometry and allied topics. East Lansing, MI; American Society for Mass Spectrometry (1985). (CONF-8505123—). Contract AC02-82ER60055.

From ASMS annual conference on mass spectrometry and applied topics; San Diego, CA, USA (26 May 1985).

Mass spectrometric and chemiluminescent studies were undertaken to determine the processes which occur when CS_2 is added to a flowing Ar afterglow. Chemiluminescence due to an ion-molecule reaction is of practical interest due to the production of chemical lasers where the required population inversion may be created by such reactions. Additional interest comes from the importance of ion-molecule reactions to understanding ionospheric and interstellar chemistry. Fundamentally, these reactions provide information concerning energy consumption and deposition into internal modes and translational degrees of freedom. Such studies further contribute to a basic understanding of the mechanisms involved in thermal energy charge transfer reactions. The visible light emission observed with the addition of CS_2 to a flowing Ar afterglow has been identified as the A$^3\pi$/sub U/ to the X$^3\pi$/sub G/ transition of CS_2^+. The population of this first excited electronic state of CS_2^+ has been accomplished by a number of techniques, including photoionization, electron impact, and Penning ionization. Endoh and coworkers were the first to identify an ionic species of Ar as the excitation source of CS_2^+ into the A state. Due to the energetics involved and experiments where a monotonic increase in the chemiluminescence intensity was observed as the pressure of Ar

was increased, they concluded that the excitation source was due to the charge transfer reaction, $Ar_3^+ + CS_2 \rightarrow CS_2^+(A^2\pi/sub\ G/) + 2Ar$. In contrast to this work, the results of the study demonstrate that the excitation source is Ar^+.

38488 **Versatile multiple modulation scheme for two-beam laser spectroscopy.** Anfinrud, P.; Struve, W.S. (Ames Lab., IA). pp 104 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

Multiple modulation techniques afford shot noise-limited detection sensitivity for two-beam laser spectroscopy. An inexpensive SSB detection scheme is reported which provides continuous tunability of both modulation frequencies (limited only by frequency roll-off in the optical modulators). This enables the use of multiple modulation with lasers (e.g. cavity-dumped systems) whose repetition rates are too low for use with previously reported modulation frequencies.

4002 Inorganic And Physical Chemistry

REFER ALSO TO CITATION(S) 38141

38489 **(AD-A—166113/1/XAB) Theoretical study of the radiative and kinetic properties of selected metal oxides and air molecules. Final technical report, 15 January 1983-5 February 1985.** Michels, H.H.; Hobbs, R.H. (United Technologies Research Center, East Hartford, CT (USA)). 1 May 1985. 89p. (UTRC—926388). NTIS, PC A05/MF A01.

A theoretical research program directed toward the study fo the energetics and LWIR radiative properties of selected uranium/oxygen band systems was undertaken. Included in this research program was the investigation of the strongest electronic and vibrational bands in the LWIR region for the species UO, UO(+), UO_2, UO(++). The program for accomplishing this research effort was formulated into three separate tasks: a) adaption of electronic structure codes to the DNA CYBER 176 System, b) calculation of pertinent electronic wave functions and energies, as a function of internuclear separation within a relativistic framework, for selected species of the uranium/oxygen system which may be important in the LWIR region, and c) calculation of electronic transition moments and transition probabilities between specific vibrational levels of the electronic states corresponding to the strongest radiating band systems belonging to the uranium/oxygen system and prediction of IR and possible optical-oscillator strengths. These calculations indicated that the species UO(+) will be efficiently solar pumped and will exhibit strong absorption/radiation. Further, efficient conversion of solar photons to IR photons for this species is predicted.

38490 **(BNL—38135) Ab initio models for electron tunnelling between transition metal complexes. Final report.** Newton, M.D. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 11p. (CONF-8605149—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011541.

From 19. Jerusalem symposium on quantum chemistry and biochemistry; Jerusalem, Israel (5 May 1986).

Electron transfer matrix elements are calculated and analyzed for several pairs of transition metal complexes of the type ML_6^{2+}-ML_6^{3+}, chosen so as to allow a comparison of t/sub 2g/(π) vs e/sub g/(σ) transfer (M = Fe, Co, and Ru), and NH_3 vs H_2O ligands, based on an apex-to-apex orientation of the reactant complexes. The magnitude of the calculated matrix elements, which span the range from non-adiabatic to strongly adiabatic coupling, are found to exhibit a pronounced dependence on transfer type (e/sub g/ > t/sub 2g/) and ligand type (NH_3 > H_2O), an effect which is correlated with the degree of mixing of the metal and ligand orbitals, using a simple LCAO-type analysis of the ab initio molecular orbitals.

38491 **(IS-T—1177) Synthesis and characterization of hexanuclear metal-metal bonded molydenum chloride sulfide cluster species.** Laughlin, S.K. (Ames Lab., IA (USA)). Jun 1986. Contract W-7405-ENG-82. 83p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012673.

A preparative method for efficient substitution of sulfide into the $Mo_6Cl_8^{4+}$ cluster to obtain a molybdenum chloride sulfide cluster has been contrived and studied in the thesis research. A number of derivatization reactions that involve placing a donor ligand in the terminal positions of the M_6X_8 unit were examined specifically to attempt dissolution of the cluster so that crystalline material suitable for x-ray work can be isolated. Chloride, n-propylamine, trimethylphosphine, and pyridine were utilized for this prupose. Analytical results demonstrate that in some but not all cases the observed pyridine deficiency at terminal sites that had been seen previously can be alleviated. 34 refs., 10 figs., 8 tabs.

38492 **(SAND—86-0806C) Raman spectroscopy of carboranes and polycarboranesiloxanes.** Shelnutt, J.A. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 15p. (CONF-860829—15). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009030.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Raman spectra of some m-carboranesiloxane polymers are compared with each other and with the spectrum of o-carborane and boron carbide. The comparisons and additional polarization studies allow the assignment of some vibrations to the icosahedral 1,7-dicarboranyl units, siloxy polymer connecting units, and substituent groups of the silicon atoms. The Raman investigation is directed toward understanding the interaction of carborane icosahedral units of boron-carbide semiconductor materials.

38493 **(SAND—86-0922) Shock-induced solid state chemistry: theoretical background.** Hori, Y. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1986. Contract AC04-76DP00789. 63p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012741.

This report is a survey of the theoretical background of solid state chemistry relevant to high pressure shock wave loading. It is intended to be a study of selected theoretical concepts which are important for laying a foundation to make quantitative predictions concerning shock-induced chemical processes in nonenergetic solids. Since solid state reactions are often quite complex even under static conditions, the report is not intended to offer quick solutions to the very complex, and sometimes ill defined problems, but is to build a perspective to gain theoretical insight into some of them. The plan of the report is as follows: In Section II, we collected a few relationships about chemical reactions from classical thermodynamics. In Section III, we reviewed the nonequilibrium solid states created under shock wave loading with special focus on defects and heat and mass transport. Section IV deals with selected concepts that may be useful to cope with reactions that result from the highly defective nonequilibrium states. Section V discusses several approaches for integrating microscopic mechanisms into continuum framework. Section VI contains some recommendations for future research. 130 refs.

38494 **(SAND—86-8225) Real-time experimental measurements of isotopic exchange between gaseous hydrogen and palladium hydride powder.** Foltz, G.W.; Melius, C.F. (Sandia National Labs., Livermore, CA (USA)). Jun 1986. Contract AC04-76DP00789. 38p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012610.

A gas flow apparatus has been constructed and used to study the isotopic exchange reaction occurring between the solid and gas phases in hydrogen (deuterium) gas flows directed through packed-powder beds of β-phase palladium dueteride (hydride). Spontaneous Raman light scattering is employed to obtain a real-time analysis of the isotopic composition of the gas (H_2, D_2, HD) exiting from the bed. In addition, gas pressure and flow rate measurements are made on the flow simultaneously with the composition measurements.

38495 EPR observations of trivalent titanium in orthophosphate single crystals. Abraham, M.M.; Boatner, L.A.; Aronson, M.A. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Chemical Physics;* **85**: No. 1, 1-6(1 Jul 1986). Contract AC05-84OR21400.

The ground state spectroscopic properties of the $3d^1$ electronic configuration ion Ti^{3+} have been investigated using EPR spectroscopy. Trivalent titanium was incorporated as a dilute impurity in single crystals of the tetragonal, zircon-structure hosts $ScPO_4$, YPO_4, and $LuPO_4$. The EPR spectrum of Ti^{3+} was observed in the as-grown orthophosphate crystals, and low temperature irradiations were not required to produce the trivalent state. The EPR results show that Ti^{3+} occupies a substitutional cation site in the host orthophosphate single crystals. Axial spin-Hamiltonian parameters were determined at 77 K, and these results are compared to those obtained previously for the $4d^1$ and $5d^1$ configuration ions Zr^{3+} and Hf^{3+} in the same host crystals. Titanium-doped orthophosphate crystals containing isotopically enriched ^{47}Ti or ^{49}Ti were also grown and employed in determinations of the hyperfine parameters. The g-values observed here for Ti^{3+}, and determined previously for Zr^{3+} and Hf^{3+} are not accounted for by the published second-order expressions indicating that additional coupling mechanisms are operative.

38496 Infrared spectra and structure of thin films of solid oxygen: A metastable phase. Jones, L.H.; Agnew, S.F.; Swanson, B.I.; Ekberg, S.A. (Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545). *Journal of Chemical Physics;* **85**: No. 1, 428-433(1 Jul 1986).

The infrared absorption spectra of thin films of solid oxygen prepared by vapor deposition is examined in detail. It is shown that at deposition temperatures between 8 and 11 K the film consists of a mixture of α-O_2 and a metastable phase we call m-O_2. The spectrum of CO in an O_2 matrix is shown to be a good marker for the presence of m-O_2 and is informative concerning the structure of this metastable phase. Studies of mixtures of $^{18}O_2$ and $^{16}O_2$ indicate that the structure of m-O_2 is complex with four nonequivalent sites for O_2 molecules and at least eight molecules per unit cell. The isotopic studies suggest the presence of weakly bound dimers as well as tetramers or higher multimers in m-O_2. It is shown that the presence of a few percent impurities such as nitrogen or argon allow the formation of and increase the stability of m-O_2 at higher temperatures. However, with or without impurities, at deposition temperatures below 8 K less m-O_2 is formed, and deposition at 5 K leads to no m-O_2 but only poorly crystallized α-O_2. It is concluded that m-O_2 is formed by epitaxial growth from a 2D structure similar to that observed by others for 1—4 monolayers of O_2 on grafoil. The spectrum of annealed α-O_2 shows phonon combinations with the fundamental O—O stretch indicative of a phonon density of states from 30—90 cm^{-1}.

38497 Resonance electronic Raman scattering in erbium phosphate crystals. Becker, P.C.; Williams, G.M.; Russo, R.E.; Edelstein, N.; Koningstein, J.A.; Boatner, L.A.; Abraham, M.M. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory; Department of Physics, University of California, Berkeley, California 94720). *Optics Letters;* **11**: No. 5, 282-284(May 1986). Contract AC03-76SF00098;AC05-84OR21400.

Resonance enhancement factors of 10 to 100 have been observed for the electronic Raman scattering transitions in crystals of pure $ErPO_4$ and 1% Er^{3+} diluted in $LuPO_4$. The resonances were excited by the 488.0-nm line of an argon-ion laser. This line is nearly coincident with the crystal-field levels of the $^4F/sub\ 7/2/$ multiplet of Er^{3+}. The differences in relative intensities between the transitions in $ErPO_4$ and those in 1% Er^{3+} in $LuPO_4$ arise from shifts in the energy levels in the two systems and suggest that quantum-mechanical interference effects play an important role.

38498 Testing site size requirements in chemisorption: Experiment and theory. Campbell, C.T.; Paffett, M.T.; Voter, A.F. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1342-1346(May 1986). Contract W-7405-ENG-36.

"Ensemble requirements" in surface chemistry refer to the number and shape of contiguous empty sites necessary for chemisorption of a particular molecule. Ensemble effects can play a major role in directing the course of surface reactions, leading, for example, to dramatic changes in catalytic selectivity when the active metal component is diluted upon alloying with an inert metal. We will review here fundamental surface science studies that have attempted to isolate and probe this site size requirement by diluting active sites on a single crystal surface with an inert metal overlayer. In these studies, initial sticking probability and saturation coverage are measured as a function of diluent metal coverage. We will emphasize recent results in our lab on the interaction of simple molecules (CO, H_2, O_2) with Cu-, Ag-, and Bi-dosed Pt(111). These show that the group IB metals (Cu, Ag, Au) are poor diluents since they cluster into two-dimensional islands. We find that adsorbed Bi spreads out uniformly over the surface and effectively tests ensemble sizes. Theoretical models based upon Monte Carlo simulations will be summarized which, when compared to such data, allow more accurate determination of ensemble sizes. These models predict uptake curves that deviate strongly from the commonly used (1-θ)/sup A/ law (A = number of sites in ensemble), which is valid only for an array of isolated ensembles.

38499 Calcium and strontium dichloride hexahydrates by neutron diffraction. Agron, P.A.; Busing, W.R. (Oak Ridge National Lab., TN, USA). *Acta Crystallographica, Section C: Crystal Structure Communications;* **42**: No. 2, 141-143(15 Feb 1986). Contract AC05-84OR21400.

$CaCl_2 \cdot 6H_2O$ and $SrCl_2 \cdot 6H_2O$, isotypic, trigonal, P321, Z=1, unit cells from X-ray Cu Kα_1, lambdasub(X)=1.54051, lambdasub(N)=1.077 A, room temperature. $CaCl_2 \cdot 6H_2O$, Msub(r)=219.08, a=7.8759 (2), c=3.9545 (2) A, V=212.43 (6) A^3, Dsub(m)=1.71, Dsub(x)=1.7126 g cm^{-3}, μ=2.566 cm^{-1}, F(000)=14.00 fm, R(F)=0.0287 for 304 unique reflections. $SrCl_2 \cdot 6H_2O$, Msub(r)=266.62, a=7.9596 (3), c=4.1243 (2) A, V=226.29 A^3, Dsub(m)=1.93, Dsub(x)=1.9565 g cm^{-3}, μ=2.430 cm^{-1}, F(000)=16.12 fm, R(F)=0.0356 for 325 unique reflections. Nine water molecules are coordinated to each metal ion. Three of these adjoin only one cation and six are shared between two such ions. These water molecules are hydrogen-bonded to the Cl^- ions so that each anion is surrounded by six H atoms in a distorted octahedral arrangement.

38500 CO oxidation on Pd/Al_2O_3. Transient response and rate enhancement through forced concentration cycling. Zhou, X.; Barshad, Y.; Gulari, E. (Univ. of Michigan, Ann Arbor). *Chemical Engineering Science;* **41**: No. 5, 1277-1284(1986). Contract FG22-84PC70785.

Catalytic oxidation of CO over Pd/Al_2O_3 was studied with a novel monolithic reactor, with inside the reactor detection of reactants and products. Periodic switching of the feed between CO/N_2 and O_2/N_2 resulted in time-averaged rates which were more than 40 times the maximum achievable steady-state rate. To our knowledge, these enhancement factors are the highest ever observed for any reaction-catalyst system. Mapping the time-averaged reaction rates in the cycle time-CO duty fraction plane resulted in a unique global maximum at each temperature and flow rate. The ratio of optimum periodic operation rate to steady-state rate does not increase monotonically with decreasing temperature but exhibits a maximum. Transient response experiments show the presence of more than one type of surface species of CO and oxygen taking part in the reaction. While the transient responses for CO and oxygen pretreated catalysts are similar in appearance, step-up and step-down responses to and from the steady state are not. The implications of these observations in terms of the possible surface processes are discussed.

38501 Measurement of the nu_2 perpendicular bending mode of Ar-HCl by intracavity far infrared laser Stark spectroscopy. Ray, D.; Robinson, R.L.; Gwo, D.H.; Saykally, R.J. (Univ. of California, Berkeley). pp 41 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

The low frequency nu_2 perpendicular bending fundamental band of the Ar-HCl van der Waals molecule has been measured in direct absorption near 34 cm^{-1} by the new technique of intracavity far infrared laser Stark spectroscopy. Ar-HCl was generated in a free jet expansion of a 2% HCl-in-Argon gas mixture within the cavity of the laser. We have observed ~ 80 spectral lines on 2 different far infrared laser lines, with excellent signal to noise (10^4). The resolution is sufficient to observe the electric quadrupole hyperfine structure of the transitions. Preliminary analysis of the spectra yields values for the following molecular constants: nu_2, B', D', q, μ', eq/sub O/Q.

38502 Intracavity far infrared laser Stark spectroscopy of supersonic molecular beams. Ray, D.; Robinson, R.L.; Gwo, D.H.; Saykally, R.J. (Univ. of California, Berkeley). pp 41 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

The author have designed and constructed a new intracavity far infrared laser absorption experiment. The spectrometer is similar to a far infrared laser magnetic resonance spectrometer, except an electric field is used instead of a magnetic field to tune the relevant energy level differences into coincidence with the fixed frequency far infrared laser. Spectra of molecules generated in supersonic expansions and in a low pressure gas cell, both within the cavity of the laser, have been obtained. The spectrometer possesses extremely high sensitivity and high resolution (< 1 MHz), and will be used to study rotational spectra of radicals and vibration-rotation spectra of weakly-bound molecules, generated and cooled to very low temperatures in supersonic jets.

38503 Measurement of the rotational spectrum of H_3O^+ by laser magnetic resonance (LMR) spectroscopy. Strahan, S.E.; Mueller, R.P.; Saykally, R.J. (Univ. of California, Berkeley). pp 71 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

The first study is reported of the rotational spectrum of an open-shell polyatomic ion, H_3O^+. Fifty-five hyperfine-Zeeman lines have been measured from three different rotational transitions, revealing both singlet and triplet hyperfine structures from the protons. An analysis was performed employing a Watson S-reduced Hamiltonian with electron spin, hyperfine, and Zeeman interaction terms. Results provide information on the electron distribution in the ion and ultimately will yield a precise molecular structure.

38504 Measurement of the rotational spectrum of OH^+ and OD^+ by laser magnetic resonance. Gruebele, M.; Mueller, R.P.; Saykally, R.J. (Univ. of California, Berkeley). pp 72 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

Rotational fine structure transitions have been observed for the OH^+ and OD^+ molecular ions V=O in the $X^3\Sigma^-$ ground state by far-infrared laser magnetic resonance spectroscopy. Measurements of N=1 withdraws 0, N=2 withdraws 1 and N=3 withdraws 2 have been made up to 17 kG for both species, with resolution of the OH^+ hyperfine structures. The data was analyzed using a modified Tinkham-Strandberg Hamiltonian for $^3\Sigma$ states.

38505 Resonance Raman studies of radiation- and photochemical transients. Tripathi, G.N.R. (Univ. of Notre Dame, IN). pp 77 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

Time-resolved techniques are applied to examine the resonance Raman spectra, structures, and kinetic behavior of transient intermediates in a number of radiation- and photo-chemical reactions. The following systems will be discussed: (1) Dihalide radical anions (Cl_2^-, Br_2^-, I_2^-) in aqueous solution. Bond dissociation energies (1.6, 1.3, 0.9 eV respectively) have been evaluated. (2) Transient species in the pulse radiolytic reactions of aqueous aniline. The Raman spectra of anilino, aniline radical cation and benzidine radical cation have been observed. (3) Photoexcited triplet (T_1) states of N-heterocyclic molecules and their reactions.

38506 Equivalence of intramolecular potential expansions in normal and valence displacement coordinates. Maessen, B.; Wolfsberg, M.; Harding, L.B. (Univ. of California, Irvine). pp 134 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

The present study presents a numerical test on the equivalence of potential expansions in normal and valence displacement coordinate space by calculating the lower vibrational states in a variational procedure. The calculations are performed for H_2O and they indicate that a fourth order Taylor series expansion in valence coordinates is not well represented by an expansion in normal coordinates which is truncated at fourth order.

38507 Configuration interaction and spin-orbit coupling in the Fox-Herzberg system of C_2. Hardwick, J.L.; Winicur, D.H. (Univ. of Notre Dame, IN). pp 138 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

Spin-orbit coupling constants have been obtained for the e^{3}PI/sub g/ state of C_2 from a remeasurement of several bands of the e^{3}PI/sub g/-a^{3}PI/sub u/ band system and a re-analysis of some of the published measurements. The spin-orbit constants A/sub v/ of the upper state are small, and the change of A/sub v/ with v is anomalously large. This behavior is entirely consistent with the assumption of a large change in orbital configuration for the e state, as predicted by ab initio calculations.

38508 Ergodic behavior and the anomalous continuum fluorescence of small molecules. Hardwick, J.L. (Univ. of Notre Dame, IN). pp 138 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

The anomalous continuum fluorescence and absorption spectra of NO_2 is interpreted as resulting from the coupling between the excited electronic states and high-lying levels of the ground electronic state which are ergodic in nature. This behavior is intimately related to the anomalous lifetime lengthening (the Douglas effect), and is proposed to account for similar anomalous continua in CS_2 and SO_2.

38509 Ab initio molecular orbital study of the vibrational frequencies of ONF and NOF. Curtiss, L.A.; Maroni, V.A. (Argonne National Lab., IL). pp 147 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

The optimized geometries and vibrational frequencies of ONF and NOF are determined using second order Moeller Plesset perturbation theory with the 6-31G basis set. The geometry and frequencies of ONF are in good agreement with experiment, whereas the vibrational frequencies of NOF are in poor agreement with the observed frequencies. The theoretical predictions support the contention of Jacox that the band observed by Smardzewski and Fox at 1886 cm^{-1} is not the NO-stretching fundamental of NOF. Also, the predicted shifts in frequencies of the nu_2 and nu_3 bands upon isotopic substitution are in sharp disagreement with experimental shifts, raising the question of whether NOF has actually been observed in low temperature matrices. The NOF isomer is calculated of NOF to ONF. The possibility that the ground state of NOF is a triplet was also investigated.

38510 Dew point/temperature curves for selected metal/metal oxide systems in hydrogen atmospheres. Rey, M.C.; Kramer, D.P.; Henderson, W.R.; Abney, L.D. (Monsanto Research Corp., Miamisburg, OH). *Welding Research Supplement;* 162-166(May 1984).

As an aid in determining metallizing, brazing and sintering conditions, a new dew point/temperature diagram is developed for selected metal/metal oxide equilibria in hydrogen atmospheres. The new diagram constitutes an expanded and more accurate version of the original set of curves developed earlier by W.H. Chang. Experiments carried out to check the calculated curves show that chemical kinetics, rather than equilibrium thermodynamics, determine the temperatures of reaction initiation for the majority of the systems investigated. In these cases the empirically determined dew point/temperature curves supersede the calculated ones for process engineering purposes. 4 references, 8 figures.

38511 Viscosity of liquid-phase methyl chloride. Rutherford, W.M. (Monsanto Research Corp., Mound, Miamisburg, OH). *Journal of Chemical and Engineering Data;* 29: No. 2, 163-165(1984). Contract AC04-76DP00053.

A high-pressure capillary viscosimeter was used to measure the viscosity of liquid-phase methyl chloride in the temperature range from 20 to 150°C. The constants of the apparatus were evaluated by calibration with gases of known viscosity. The precision of the measurements is estimated to be +/- 1% in the normal liquid range and +- 5% in the critical region. 13 references, 2 figures, 3 tables.

4003 Organic Chemistry

REFER ALSO TO CITATION(S) 37273, 37298, 37315, 37422, 37431, 37438, 37444, 37699, 38095, 39072

38512 (DOE/ER/13193—2) Measurement and prediction of liquid mixture thermal conductivity and viscosity. Final report. Rowley, R.L. (Brigham Young Univ., Provo, UT (USA)). 15 Jun 1986. Contract FG02-84ER13193. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012508.

A local composition model has been developed for prediction of liquid mixture thermal conductivities and shear viscosities from pure component values and readily available binary thermodynamic data. The method is applicable to any number of components and requires no adjustable parameters. Viscosities were measured in an Ubelohde capillary viscometer and densities were measured in a Mettler-Paar densitometer over the whole composition range for 24 binary and 20 ternary liquid mixtures at 25°C and ambient pressure. A new, transient, hot-wire thermal conductivity apparatus was constructed and used to measure the thermal conductivity over the whole composition range at 25°C and 1 atm for 24 ternary mixtures, including 14 pure components and the binary limits of the ternaries. These data indicate that the local composition model works quite well for both thermal conductivity and shear viscosity. 9 figs., 6 tabs.

38513 (EPRI-CS/EA/EL—4480, pp 7.20-7.21) Pyrolysis and combustion of PCB contaminated transformer fluids. Eadon, G. (New York State Dept. of Health, Albany). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A study was carried out to assess the PCDF-forming potential of dilute (50-5000 ppm) solutions of Aroclor 1254 in various solvents of potential interest to the utility industry (mineral oil, tetrachloroethylene, and silicone oil). The experimental apparatus used to produce pyrolysis conditions is described. A similar description is provided for the equipment used to produce combustion conditions. No results are given, and no conclusions are drawn.

38514 (EPRI-CS/EA/EL—4480, pp 8.1-8.29) FORMEL - a new, safer, non-flammable dielectric and coolant for transformers. Slinn, D. (I.S.C.; Chemicals, Princeton, NJ). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A test program is outlined describing the search for a dielectric fluid that is non-flammable under high energy arcing conditions and which, at the same time, gives an acceptable toxicity profile in the immediate vicinity of the test device during arcing. A number of fluids were studied using a combination of switching, destructive testing and analysis of fluid decomposition products as screening techniques. These studies, in conjunction with parallel examination of the fluid for other necessary properties, led to the selection of a blend of halocarbons as giving the best performance. Destructive testing of a 500 kVA transformer filled with this fluid showed that it passed the target safety criteria. The fluid has been shown to exhibit a satisfactory performance across the spectrum of properties necessary for a transformer fluid. In particular, the combination of its low viscosity, high density and high coefficient of expansion leads to outstanding coolant characteristics. Commercialization has taken place and the trade name Formel has been allocated. Each component of Formel has been used widely by industry for many years and the toxicology has been studied extensively. It is considered, therefore, that the safety and environmental profile is acceptable throughout manufacture, use, maintenance and disposal scenarios. 4 references, 3 figures, 19 tables.

38515 (EPRI-CS/EA/EL—4480, pp 8.30-8.33) State-of-the-art review of combustion/pyrolysis by-products of PCB substitutes. Marsh, J.R. (SCS Engineers, Long Beach, CA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Two types of esters, phthalate and benzylneocaprate, have been considered as PCB substitutes. Pyrolysis will produce gases similar to and no more toxic than those obtained from hydrocarbons. One major decomposition product is phthalic anhydride. Polydimethyl siloxane has been widely used as a retrofill fluid. During thermal decomposition, amorphous silica, several cyclic siloxanes, and a variety of simple hydrocarbons are produced. Animal inhalation tests on pyrolyzed siloxanes have generally indicated a low toxicity. Other substitute fluids considered include methylated diphenylethane, phenylxylylethane, butylated monochlorodiphenylether, alkyl biphenyls, paraffinic hydrocarbons, and perchloroethylene. Dielectric gases and solids are also considered. Chlorofluorocarbons are the principal gaseous PCB substitutes, epoxy resins and polyvinyl chloride are the principal solids. The solids in particular can decompose to toxic and hazardous byproducts.

38516 (MLM—3348) Surface characterization of an energetic material, pentaerythritoltetranitrate (PETN), having a thin coating achieved through a starved addition microencapsulation technique. Worley, C.M. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 7 May 1986. Contract AC04-76DP00053. 47p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012262.

The objective of this research was to: (1) determine the nature of a thin coating on an explosive material which was applied using a starved addition microencapsulation technique, (2) understand the coating/crystal bond, and (3) investigate the wettability/adhesion of plastic/solvent combinations using the coating process. The coating used in this work was a Firestone Plastic Company copolymer (FPC-461) of vinylchloride/trifluorochloroethylene in a 1.5/1.0 weight ratio. The energetic explosive examined was pentaerythritoltetranitrate (PETN). The coating process used was starved addition followed by a solvent evaporation technique. Surface analytical studies, completed for characterization of the coating process, show (1) evidence that the polymer coating is present, but not continuous, over the surface of PETN; (2) the average thickness of the polymer coating is between 16-32 A and greater than 44 A, respectively, for 0.5 and 20 wt % coated PETN; (3) no changes in surface chemistry of the polymer or the explosive mate-

rial following microencapsulation; and (4) the presence of explosive material on the surface of 0.5 wt % FPC-461 coated explosives. 5 refs., 15 figs., 6 tabs.

38517 **Analysis of electron spin echo modulation in randomly oriented solids: ^{15}N modulation of radical cations of bacteriochlorophyll a and the primary donor of photosynthetic bacterium Rhodospirillum.** Lin, C.P.; Bowman, M.K.; Norris, J.R. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439; Department of Chemistry, The University of Chicago, Chicago, Illinois 60637). *Journal of Chemical Physics;* **85**: No. 1, 56-62(1 Jul 1986). Contract W-31-109-ENG-38.

The electron spin echo modulation spectrum of organic radicals in randomly oriented solids is analyzed in detail for axially symmetric hyperfine tensors. Numerical calculations of the modulation spectra are compared with experimental results from the radical cations of ^{15}N labeled bacteriochlorophyll a and the primary donor of photosynthetic bacterium Rhodospirillum rubrum. Determination of hyperfine coupling constants from experimental spectra in the frequency domain is complicated by the anisotropy of modulation intensity, the effects of second and higher order hyperfine interactions, overlapping spectra from several nuclei, multiple quantum coherences among hyperfine levels, and the spectrometer deadtime. Nonlinear least-squares analysis of the time domain data [Tang et al., J. Chem. Phys. 83, 4197 (1985)] is the only reliable method for extracting coupling constants from randomly oriented organic radicals.

38518 **Kinetic energies released in the loss of nitrogen oxide from substituted nitroaromatic anions.** McLuckey, S.A.; Glish, G.L. (Analytical Chemistry Div., Oak Ridge National Lab., Oak Ridge, TN). pp 148-149 of Proceedings of the 33rd annual conference on mass spectrometry and allied topics. East Lansing, MI; American Society for Mass Spectrometry (1985). (CONF-8505123—). Contract AC05-84OR21400.

From ASMS annual conference on mass spectrometry and applied topics; San Diego, CA, USA (26 May 1985).

The loss of nitrogen oxide from nitroaromatic cations and anions is one of the major decomposition reactions for these classes of ions. Several mechanisms have been proposed for NO loss from these ions. Evidence for different mechanisms comes from widely different kinetic energy release values (T) measured in the mass-analyzed ion kinetic energy (MIKE) spectra. In some cases, more than one process is reflected in the MIKE spectrum by the presence of a composite peak consisting of both high and low T components. The magnitude of T reflects the energy surface over which the decomposition takes place. Large T values are associated with reactions with significant critical energies for the reverse reaction, whereas small T values are evidence for little or no reverse critical energy. It has been noted that the loss of NO from many substituted nitroaromatic cations takes place with usually large T values of up to 1 eV. The loss of NO from nitroaromatic anions also often proceeds with large releases of translational energy, particularly in the case of dinitroaromatic compounds. This paper reports T values measured from MIKE spectra of several dinitroaromatic anions. Peak shapes have also been recorded following collisional activation.

38519 **Analysis of the stimulated Raman spectrum of the nu_{16}/nu_9+nu_{18} Fermi diad of benzene.** Esherick, P.; Owyoung, A.; Pliva, J. (Sandia National Labs., Albuquerque, NM). pp 36 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

The Raman spectrum of benzene was measured with the aid of the ionization-detected stimulated Raman technique in the region 1580-1625 cm^{-1} containing the nu_{16} E/sub 2g/ fundamental band and the nu_8+nu_{18} E/sub 2g/ combination band enhanced by close Fermi resonance with the fundamental. With the -0.007 cm^{-1} resolution attained, the strong ^{0}O and /sup s/S branch lines were completely resolved for the higher K values. Both bands have the regular structure of $\Delta K = +- 2$, $\Delta 1 = +- 1$ transitions, but the lower frequency band exhibits a perturbation localized near K = 21, which was ascribed to a J/sub x,y-/ Coriolis interaction with the nu_7+nu_{18} E/sub 1g/ state. A Hamiltonian matrix containing the three states and their Fermi, Coriolis, and l-type interactions was used for the treatment of the upper states of the observed bands yielding a set of spectroscopic constants which reproduce the observed spectrum with an over-all standard deviation of 0.0025 cm^{-1}. The unperturbed origins of the nu_{16} and nu_8+nu_{18} states are at 1600.966 and 1599.881 cm^{-1} respectively: the identity of the lower lying state as nu_8+nu_{18} was established by its constant $C\delta = +0.05498$ cm^{-1} which is very close to the value reported in the literature for nu_{18}. 1 reference.

38520 **Time-resolved resonance Raman spectroscopy of transient species formed during the oxidation of cytochrome oxidase by dioxygen.** Babcock, G.T.; Jean, J.M.; Johnston, L.N.; Palmer, G.; Woodruff, W.H. (Michigan State Univ., East Lansing). pp 142 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

Cytochrome oxidase is responsible for perhaps 90% of the aerobic metabolism on earth. Time resolved resonance Raman spectroscopy has been used to study the reoxidation of the reduced and mixed valence forms of this enzyme by dioxygen. Laser flash photodissociation of CO from the carbonmonoxy complex of the enzyme, after this species had been rapidly mixed with oxygenated buffer, was used to initiate the reaction. The immediate product of the flow-flash reaction of the CO-blocked, fully reduced enzyme has a Raman spectrum which is undistinguishable from that of the reduced enzyme. This intermediate is replaced in the first few microseconds by a photolabile species which has Raman frequencies characteristic of oxygenated heme. The O_2 complex is the major species during the 10-50 μs of the reaction but converts subsequently to a series of nonphotolabile intermediates as the oxidation reaction proceeds. In the mixed valence oxidaes system, the oxy intermediate is replaced by a nonphotolabile species in which a_3 is oxidized with t/sub 1/2/ 200 μs.

4004 Electrochemistry

REFER ALSO TO CITATION(S) 38476

38521 (EPRI-CS/EA/EL—4480, pp 7.7-7.10) **Formation of PCDFs and PCDDs in electrical discharges.** Koch, R.E.; Rouse, T.O.; DeRoos, F.L. (General Electric Co.). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Mixtures of PCBs and TCBs (chlorinated benzenes), called askarels, have been used as the liquid dielectric insulation and heat transfer material in transformers. PCDFs are products of partial oxidation of PCBs and both PCDFs and PCDDs are products of combustion of TCBs. Studies of the formation of PCDF and PCDD have been carried out in controlled simulations of high energy electrical breakdown -arcing in transformers. Askarels alone and mineral oil containing low concentrations of askarels have been examined. It appears that arcing TCB and PCBs under the conditions used does not result in the formation of PCDFs and PCDDs. If anything, there appears to have been a reduction in the solution concentrations. This may be due to adsorption of the pre-existing furans and dioxins on the carbonaceous material forming in the discharge. 1 reference, 3 tables.

38522 **Combined electrochemical/surface science investigations of Pt/Cr alloy electrodes.** Daube, K.A.; Paffett, M.T.; Gottesfeld, S.; Campbell, C.T. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1617-1620(May 1986). Contract W-7405-ENG-36.

Chromium addition improves the performance of carbon-supported Pt electrodes for oxygen reduction in phosphoric acid fuel cells. To clarify the role of chromium and its chemical nature

at the electrode surface, we have performed a combined electrochemical/surface science investigation of a series of bulk Pt/sub x/ Cr/sub 1-x/ alloys (0< or =x< or =1). In this paper we report the surface characterization of the starting electrodes by XPS, electrochemical results from cyclic voltammetry in 85% phosphoric acid, and postelectrochemical surface characterization. For Cr contents less than 40%, the electrodes were quite stable up to +1.6 V versus dynamic hydrogen electrode (DHE). The surface Cr was largely oxidized to Cr^{+3} for surfaces at open circuit and those exposed at potentials <+1.4 V. For intermediate Cr levels, Cr was leached from the surface region by +1.5 V, leaving a porous Pt electrode with increased electrochemical hydrogen adsorption capacity. For Pt/sub 0.2/ Cr/sub 0.8/, treatments at +1.4 V and above led to the appearance of Pt^{+4} and Cr^{+6} species, apparently stabilized in a porous phosphate overlayer up to 50 A thick. The Pt electrochemical hydrogen adsorption capacity was simultaneously increased by a factor of 15.

4005 Photochemistry

REFER ALSO TO CITATION(S) 37331, 38436, 38452, 38476, 38758, 38785, 38963

38523 Production of gallium atoms by excimer laser photolysis of trimethylgallium. Baughcum, S.L.; Oldenborg, R.C.; Winn, K.R.; Hof, D.E. (Chem. Div., Los Alamos National Lab., Los Alamos, NM 87545). pp 314-321 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The gas phase kinetics of group III elements such as gallium are important in potential chemically-driven energy-transfer lasers and in chemical vapor deposition processes in the electronics industry. Excimer laser photodissociation of volatile gallium compounds via multiple-photon processes provides, in principle, a convenient room-temperature source of gallium atoms for study using laser photolysis/laser-induced fluorescence techniques. In this paper, the authors report preliminary results on the production of atomic gallium from the multiple-photon dissociation of trimethylgallium at 193nm. Prompt emission from a number of excited gallium states (5 ^{2}S, 4 ^{2}D, 6 ^{2}S, 6 ^{2}P^o, 5 ^{2}D, and 4 ^{4}P) is observed. The time histories of the ground state (4 ^{2}P^o /sub 1/2/) and the metastable state (4 ^{2}P^o /sub 3/2/) have been measured using laser-induced fluorescence. The resulting time profiles are complicated even in the absence of an added reactant gas by the apparent production of ground state gallium at relatively long times ($\approx$10 μs) after the excimer laser pulse. Possible mechanisms for this (i.e., radical reactions to produce gallium, energy transfer, cascading from high lying metastable states, ionic processes, etc.) are being investigated. These results indicate that the photodissociation of trimethylgallium at 193 nm is complex. Mechanistic considerations suggest that photolysis at other wavelengths and with other precursors may lead to a cleaner source of gas-phase atomic gallium for kinetic studies, and these studies are in progress.

38524 Lifetime and quenching measurements of C_2H emission produced by vacuum ultraviolet photolysis of C_2H_2. Tiee, J.J.; Sander, K.; Quick, C.R. Jr.; Romero, R.J.; Estler, R. (Los Alamos National Lab., Los Alamos, NM 87545). pp 322-329 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

State-of-the-art tunable vuv sources are used to produce excited C_2H photofragments (C_2H) via the photolysis of acetylene molecules. The quenching rate constants of the C_2H emission by a number of species are determined. The collision-free fluorescence lifetimes are measured at different excitation wavelengths. The excitation energy threshold for producing the observed emission is determined. In addition, a correlation between the excitation energy and the emission wavelength is observed.

4006 Radiation Chemistry

REFER ALSO TO CITATION(S) 38401

38525 (N—86-20518) Relative fluorescent efficiency of sodium salicylate between 90 and 800 eV. Angel, G.C.; Samson, J.A.R.; Williams, G. (Nebraska Univ., Lincoln (USA)). 1986. 16p. NTIS, PC A02/MF A01.

The relative fluorescent quantum efficiency of sodium salicylate was measured between 90 and 800 eV (138 -15 A) by the use of synchrotron radiation. A general increase in efficiency was observed in this spectral range except for abrupt decreases in efficiency at the carbon and oxygen K-edges. Beyond the oxygen K-edge (532 eV) the efficiency increased linearly with the incident photon energy to the limit of the present observations.

4007 Radiochemistry And Nuclear Chemistry

38526 (LA-UR—86-2000) Stabilization of actinides and lanthanides in unusually high oxidation states. Eller, P.G.; Penneman, R.A. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 35p. (CONF-860602—4). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012376.

From 17. rare earth research conference; Hamilton, Ontario, Canada (8 Jun 1986).

Chemical environments can be chosen which stabilize actinides and lanthanides in unusually high or low oxidation states and in unusual coordination. In many cases, one can rationalize the observed species as resulting from strong charge/size influences provided by specific sites in host lattices (e.g., Tb(IV) in $BaTbO_3$ or Am(IV) in polytungstate anions). In other cases, the unusual species can be considered from an acid-base viewpoint (e.g., U(III) in AsF_5/HF solution or Pu(VII) in Li_5PuO_6). In still other cases, an interplay of steric and redox effects can lead to interesting comparisons (e.g., instability of double fluoride salts of Pu(V) and Pu(VI) relative to U, Np, and Am analogues). Generalized ways to rationalize compounds containing actinides and lanthanides in unusual valences (particularly high valences), including the above and numerous other examples, will form the focus of this paper. Recently developed methods for synthesizing high valent f-element fluorides using superoxidizers and superacids at low temperatures will also be described. 65 refs., 8 figs., 9 tabs.

38527 Production of no-carrier added ^{67}Cu. Mirzadeh, S.; Mausner, L.F.; Srivastava, S.C. (Brookhaven National Lab., Upton, NY, USA). *Applied Radiation and Isotopes;* 37: No. 1, 29-36(1986). Contract AC02-76CH00016.

Copper-67 has been produced at the BLIP by ^{68}Zn(p,2p) and ^{70}Zn(p,α) reactions with 193 MeV protons and at the HFBR using the ^{67}Zn(n,p) route. The effective cross-sections of Zn(p,2pxn)$^{61\ 64}$ ^{67}Cu reactions were measured at 200 MeV and compared with predicted values obtained from semi-empirical formulae given by Silberberg and Tsao. From these cross-sections, the fraction of ^{64}Cu in the final ^{67}Cu preparations was estimated and compared with the experimental values. A procedure has been developed consisting of electrodeposition and ion-exchange for isolation of no-carrier-added radiocopper from a Zn target. The method is adaptable for remote hot cell operation. The overall radiochemical yield of ^{67}Cu and the separation factors from a Zn target and other radio-nuclides were evaluated. The saturation yield of ^{67}Cu produced by the fast neutron ^{67}Zn(n,p) reaction and the corresponding cross-section were remeasured. Experiments have been initiated to attach ^{67}Cu to monoclonal antibodies for immunotherapy applications.

38528 Synthesis of [^{14}C]methylphosphonic difluoride. Bechtold, W.E.; Dahl, A.R. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM, USA. Inhalation Toxicology Research Inst.). *Journal of Labelled Compounds and Radiopharmaceuticals;* 22: No. 11, 1181-1186(Nov 1985). Contract AC04-76EV01013.

The synthesis of [^{14}C] methylphosphonic difluoride is described. First, [^{14}C]methyl iodide was used to catalyse the conver-

sion of trimethyl phosphite to dimethyl [^{14}C]methylphosphonate by the Arbusov reaction. The dimethyl methylphosphonate was then chlorinated with PCl_5 and fluorinated with SbF_3. Radio-chemical yield from the reaction was 25%.

38529 Measurement of the infrared-active stretching fundamental (nu_3) of UF_6. McDowell, R.S.; Aldridge, J.P.; Filip, H.; Flicker, H.; Holland, R.F.; Kim, K.C.; Magnuson, D.W.; Maier W.B. II; Person, W.B.; Smith, D.F.; Werner, G.K. (Los Alamos National Lab., NM). pp 151 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

High-resolution (Doppler-limited) spectra of the infrared-active stretching fundamental nu_3 of $^{235}UF_6$ have been obtained between 620.6 and 633.5 cm^{-1} using tunable semiconductor diode lasers. Interference from hot bands was suppressed by cooling the UF_6 in a supersonic expansion, and useful monomer concentrations were produced with effective temperatures of < 100 K. Portions of the band from P(77) to R(66) will be shown. All transitions from the vibrational ground state have been assigned; the nu_3 Q branches of both $^{235}UF_6$ and $^{238}UF_6$ have been analyzed, and the isotope shift accurately measured. The isotope shift and the Coriolis constant $zeta_3$ have been used to refine the general quadratic force field of UF_6. The Cartesian displacement coordinates of both infrared-active fundamentals will be illustrated and compared with those of SF_6.

38530 Analysis of the infrared-active stretching fundamental of UF_6. Krohn, B.J.; Brock, E.G.; Fox, K.; Galbraith, H.W.; McDowell, R.S.; Patterson, C.W. (Los Alamos National Lab., NM). pp 151 of Fortieth symposium on molecular spectroscopy. Columbus, OH; Ohio State University (1985). (CONF-8506182—).

From 40. symposium on molecular spectroscopy; Columbus, OH, USA (17 Jun 1985).

Assignments of the UF_6 spectra described in the preceding paper will be discussed. A total of 43 line frequencies and 110 frequency differences extending in J to P(77), Q(91), and R(67) has been used to fit seven spectroscopic constants. High-J data allowed the independent fitting of (Bzeta)$_3$ and hence of the rotational constants B' and B/sub O/. The derived U-F bond length in the ground vibrational state is r/sub O/ = 1.9962 +- 0.0007 A. The use of frequency differences as a supplement to absolutely-calibrated transition frequencies in fitting spectroscopic and molecular constants will be discussed.

4008 Combustion, Pyrolysis, And High-temperature Chemistry

REFER ALSO TO CITATION(S) 37797, 38192, 38480, 38481, 38662

38531 (DOE/PC/81003—T2) Alternative method for the removal of oxides of nitrogen and sulfur from combustion processes. Second quarterly technical status report, September 17-March 31, 1986. Joshi, A.V. (Ceramatec, Inc., Salt Lake City, UT (USA)). 1986. Contract AC22-85PC81003. 63p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010680.

The program is on schedule. The current program has clearly demonstrated that SO/sub x/ and NO/sub x/ can be decomposed to elemental sulfur and nitrogen by a zirconia solid electrolyte cell. The Ceramatec and VSM team have also carried out design system modeling which suggests that a cell design is feasible that can meet system integration and economic requirements. The achievement of these major milestones verifies that the proposed program approach is feasible and provides a strong incentive to continue the program into Phase II.

38532 (LBL—20863) Heat transfer during laminar flow flame quenching: effect of fuels. Huang, W.M.; Vosen, S.R.; Greif, R. (Lawrence Berkeley Lab., CA (USA)). Dec 1985. Contract AC03-76SF00098. 24p. (CONF-860804—9). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007490.

From 21. international symposium on combustion; Munich, F.R. Germany (3 Aug 1986).

Wall heat fluxes were obtained in a constant volume combustion chamber for methane-air, ethylene-air and propane-air mixtures. The experiments were performed at pressure near atmospheric over a range of equivalence ratios from 0.8 to 1.2. The unsteady heat fluxes for the three fuels were all correlated by using the heat release rates of the flames prior to quenching and the thermal diffusivity and the flame speed. The calculations were made using a finite difference method and an integral method. Two step chemical kinetics was used in the finite difference calculations and a simplified ignition temperature approach was employed in the integral method. The results from the finite difference calculation were in good agreement with the experimental data. In the integral method, choosing a single value for the dimensionless ignition temperature for all three fuels also yielded good agreement with the experimental data. The maximum wall heat flux accounts for one third of the steady laminar flame heat release rate for three fuels. 20 refs., 6 figs., 2 tabs.

38533 (N—86-20517) Combustion characteristics in the transition region of liquid fuel sprays. Final Report, January 1983-September 1985. Cernansky, N.P.; Namer, I.; Tidona, R.J. (Drexel Univ., Philadelphia, PA (USA)). Jan 1986. 56p. NTIS, PC A04/MF A01.

A number of important effects have been observed in the droplet size transition region in spray combustion systems. In this region, where the mechanism of flame propagation is transformed from diffusive to premixed dominated combustion, the following effects have been observed: (1) maxima in burning velocity; (2) extension of flammability limits; (3) minima in ignition energy; and (4) minima in NOx formation. A monodisperse aerosol generator has been used to form and deliver a well controlled liquid fuel spray to the combustion test section where measurements of ignition energy have been made. The ignition studies were performed on monodisperse n-heptane sprays at atmospheric pressure over a range of equivalence ratios and droplet diameters. A capacitive discharge spark ignition system was used as the ignition source, providing independent control of spark energy and duration. Preliminary measurements were made to optimize spark duration and spark gap, optimum conditions being those at which the maximum frequency or probability of ignition was observed. Using the optimum electrode spacing and spark duration, the frequency of ignition was determined as a function of spark energy for three overall equivalence ratios (0.6, 0.8, and 1.0) and for initial droplet diameters of 25, 40, 50, 60, and 70 micro m.

38534 (N—86-20753) New method for determining heats of combustion of gaseous hydrocarbons. Singh, J.J.; Sprinkle, D.R.; Puster, R.L. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Dec 1985. 13p. (NASA-TP—2531; L—16054). NTIS, PC A02/MF A01.

As a spin off of a system developed for monitoring and controlling the oxygen concentration in the Langley 8-foot High Temperature Tunnel, a highly accurate on-line technique was developed for determining heats of combustion of natural gas samples. It is based on measuring the ratio m/n, where m is the (volumetric) flowrate of oxygen required to enrich the carrier air in which the test gas flowing at the rate n is burned, such that the mole fraction of oxygen in the combustion product gases equals that in the carrier air. The m/n ratio is directly related to the heats of combustion of the saturated hydrocarbons present in the natural gas. A measurement of the m/n ratio for the test gas can provide a direct means of determination of its heat of combustion by using the calibration graph relating the m/n values for pure saturated hydrocarbons with their heats of combustion. The accuracy of the technique is determine solely by the accuracy with which the flowrates m and n can be measured and is of the order of 2 percent in the present study. The theoretical principles and experimental results are discussed.

38535 (N—86-21635) Methane oxidation behind reflected shock waves: ignition delay times measured by pressure and flame band emission. Brabbs, T.A.; Robertson, T.F. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 23p. (NASA-TM—87268; E—2956; CONF-860536—1). NTIS, PC A02/MF A01.

From Technical meeting on fluid mechanics and chemistry of the combustion process; Cleveland, OH, USA (5 May 1986).

Ignition delay data were recorded for three methane-oxygen-argon mixtures (phi = 0.5, 1.0, 2.0) for the temperature range 1500 to 1920 K. Quiet pressure trances enabled us to obtain delay times for the start of the experimental pressure rise. These times were in good agreement with those obtained from the flame band emission at 3700 A. The data correlated well with the oxygen and methane dependence of Lifshitz, but showed a much stronger temperature dependence (phi = 0.5 delta E = 51.9, phi = 1.0 delta = 58.8, phi = 2.0 delta E = 58.7 Kcal). The effect of probe location on the delay time measurement was studied. It appears that the probe located 83 mm from the reflecting surface measured delay times which may not be related to the initial temperature and pressure. It was estimated that for a probe located 7 mm from the reflecting surface, the measured delay time would be about 10 microseconds too short, and it was suggested that delay times less than 100 microsecond should not be used. The ignition period was defined as the time interval between start of the experimental pressure rise and 50 percent of the ignition pressure. This time interval was measured for three gas mixtures and found to be similar (40 to 60 micro sec) for phi = 1.0 and 0.5 but much longer (100 to 120) microsecond for phi = 2.0. It was suggested that the ignition period would be very useful to the kinetic modeler in judging the agreement between experimental and calculated delay times.

38536 (TKK-KO/ET—5) Pressurized fluidized bed combustion. Hulkkonen, S.; Jahkola, A. (Helsinki Univ. of Technology, Otaniemi (Finland). Inst. of Energy Engineering). Jun 1985. 196p. (In Finnish). NTIS (US Sales Only), PC A09/MF A01. File Number DE86752111.

The purpose of this study was to examine pressurized fludized bed combustion (PFBC) and it's applications. In the beginning of the report foreign experimental facilities and conceptual plant-scale designs are presented. In addition, economics of different concepts have been compared. Finally special features of PFBC are examined. Research in PFBC is mainly centered on applications of burning coal. The most obvious application of PFBC is in a combined cycle (CC) system. The power generating efficiency of a combined cycle is potentially five units of percentage higher than that of conventional pulverized fired plant with wet scrubbers to remove SO_2. The presented conceptual designs are mainly big coal burning PFBC combined cycle plants. In Sweden, however, they are developing a district heating power plant in which flue gases of the wet fuel are condensed under high pressure. The condensing heat is used for district heating. The most important advantages of PFBC are high combustion efficiency, environmental performance and the small size of the equipment. SO_2 can be captured during the combustion process and NOsub(x) emissions are low. The most difficult problems are fuel feeding against pressure, particulate removing before gas turbine and erosion/corrosion of gas turbine materials.

38537 Kinetics of the reaction of NCO with ethene and oxygen over the temperature range 295-662K. Perry, R.A. (Sandia National Labs., Combustion Research Facility, Livermore, CA). *American Chemical Society, Division of Gas and Fuel Chemistry, Preprints;* **31**: No. 2, 90-94(Apr 1986). (CONF-860425—).

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

The NCO radical is intimately connected with nitric oxide formation from fuel-bound nitrogen in combustion systems. In order to model nitrogen chemistry in combustion systems, it is essential to explore the possible chemical reactions that might enter into any extensive model of nitrogen chemistry in these systems. While little has been done toward understanding the detailed chemistry of the NCO radical with combustion species, certain reactions can be anticipated to occur based upon analogous electrophilic radical/molecule reactions. Unsaturated hydrocarbons are found extensively in combustion, with ethene being a major component after pyrolysis of larger fuels. This reaction was chosen to facilitate predictions of NCO radical reactions with unsaturated hydrocarbons and hence to understand more fully nitrogen chemistry in rich combustion systems. To the extent that this reaction occurs at combustion temperatures, it is a pathway to recycle reactive nitrogen back into fuel-bound nitrogen i.e., HCN.

38538 Mathematics of combustion. Buckmaster, J.D.; Rabitz, H.; Williams, F.A.; Fickett, W.; Clarke, J.F. Philadelphia, PA; Society for Industrial and Applied Mathematics (1985). 266p.

The applications of numerical techniques to the study of combustion processes is considered. The basic equations governing combustion processes are introduced, and some novel approaches to combustion reaction modelling are described. Among the specific applications discussed are: the Burger and Korteweg-de Vries equations of detonation processes; turbulent combustion modelling; and analysis of finite amplitude waves in combustible gases.

38539 Bunsen flame hydrodynamics. Wagner, T.C.; Ferguson, C.R. (Ford Motor Co.). *Combustion and Flame;* **59**: 267-272(1985).

An investigation into the structure of premixed Bunsen flames was performed to determine whether by using laser velocimetry an unambiguous means of measuring laminar flame speed could be devised and to provide data by which theoreticians could critically evaluate their predictions. Data presented for the former include the axisymmetric flow field and a comparison of cone angles obtained from direct and schlieren photographs of the flame. Data presented for the latter include, for varying equivalence ratios and cone angles, the radius of curvature of the tip and change in velocity through the tip. The centerline velocity was found to decay as a function of axial distance, and a noncoincidence of schlieren and luminous surfaces was observed. When normalized by a preheat thickness (based on the harmonic mean of the thermal conductivity), the behavior of the radius of curvature of the tip compared well with a recent theoretical prediction. 13 references, 5 figures.

38540 Short communication on the reaction zone thickness of premixed laminar flames. O'Rourke, P.J.; Stein, L.R. (Los Alamos National Lab., NM). *Combustion Science and Technology;* **38**: 337-343(1984).

The authors compute numerically the structure of planar premixed laminar flames in a gas undergoing a single chemical reaction whose activation energy is large. In agreement with previous studies, it is found that the reaction zone occupies a significant fraction of the total flame zone thickness for realistic values of the dimensionless activation energy β. This is illustrated graphically in plots of the convection, diffusion, and heat-release terms of the enthalpy equation. The authors discuss the implications of a thick reaction zone for the numerical modeling of laminar flames and for results obtained by the method of activation energy asymptotics. 7 references, 1 figure, 2 tables.

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REFER ALSO TO CITATION(S) 37438

38541 (LBL—20893) Application of program POISSON to axially-symmetric problems - magnetostatic and electrostatic - with use of a prolate spheroidal boundary. Caspi, S.; Helm, M.; Laslett, L.J. (Lawrence Berkeley Lab., CA (USA)). Jan 1986. Contract AC03-76SF00098. 69p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012826.

A version of the relaxation program POISSON has been produced that, for magnetostatic problems, can apply a boundary condition consistent with no external sources being present. This capability includes the treatment of axially-symmetric cases (using A* = rhoA as the working variable) with a boundary whose form is that of a prolate spheroid (and hence tends toward spherical in

the limit eta = $a/\sqrt{a^2 - b^2} \rightarrow \infty$). [LBL-18798/UC-28 (December 1984)]. The treatment of electrostatic problems (to obtain solutions for the scalar potential V) necessarily must differ in detail from the treatment of magnetostatic problems in cases of axial symmetry. It seems desirable, therefore, first to review the magnetostatic treatment that has been adopted for such axially-symmetric magnetostatic problems and then to suggest an analogous treatment that might similarly be introduced into the program to permit solution of similar electrostatic problems (again through the introduction of a prolate spheroidal boundary).

38542 **(SAND—86-1321C) Current problems in solid dynamics.** Herrmann, W. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 15p. (CONF-8606137—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011653.

From 30. anniversary symposium of the Institute of Mechanics; Beijing, China (8 Jun 1986).

Current and future problems are addressed in the field of solid dynamics, that is, the response of materials and structures to explosions, high velocity impacts and pulsed radiation. Since such responses usually involve large deformations and nonlinear material behavior, numerical solutions are used almost exclusively for engineering design and performance assessment. Limited potential is forseen for future development of finite difference or finite element methods, but the development of algorithms implementing them, with particular emphasis on data and logic flow on vector and parallel computer architectures, hold promise of large increases in potential efficiency and the capability to do more realistic computer modeling, particularly when algorithms and architectures are developed to work together. Exact analytic solutions to test problems to validate the numerical methods are needed. The question of stability and convergence of the numerical methods for nonlinear problems is very important, and this difficult area needs attention. Many constitutive equations describing nonlinear material behavior are of incremental and rate type, and admit various instabilities and bifurcations in initial-boundary value problems of engineering interest, such instabilities being commonly observed experimentally. Qualitative analysis of such behavior of the differential equations is very important to ensure that special numerical solutions are physically correct. 13 refs.

38543 **Interactions among friction wear, and system stiffness. Part 3. Wear model.** Aronov, V.; D'Souza, A.F.; Kalpakjian, S.; Shareef, I. (Illinois Institute of Technology, Chicago). *Journal of Lubrication Technology;* No. 83-Lub-36, 1-5(1983). Contract AC02-82ER12071.

From ASME/ASLE joint lubrication conference; Hartford, CT, USA (18-20 Oct 1983).

It is shown that wear is an increasing function of system stiffness. The increase in the frequency of the applied load oscillations in normal direction causes increase of number of loading cycles per unit time that, in turn, causes increased rate of wear particles formation due to fatigue. A wear model has been developed which accounts for slider oscillation in the normal direction. Experimental data correlate very well with the theoretical analysis. 11 references, 7 figures, 3 tables.

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REFER ALSO TO CITATION(S) 37334, 37434, 37485, 37516, 37517, 37520, 37523, 37526, 37598, 38541, 38578, 38705, 38706, 38752, 39420

38544 **(AGARD-R—22) Special course on cryogenic technology for wind tunnel testing.** (Advisory Group for Aerospace Research and Development, 92 - Neuilly-sur-Seine (France)). Jul 1985. 408p. (CONF-8504244—). NTIS, PC A18/MF A01.

From Special course on cryogenic technology for wind tunnel testing; Rhode-Saint-Genese, Belgium (22 Apr 1985).

Following a brief review of the development and early application of cryogenic wind tunnels, the 16 lectures examine the following aspects of cryogenic wind tunnel technology related to the design and operation of cryogenic tunnels: cryogenic engineering and safety, properties of materials at cryogenic temperatures, model design requirements and fabrication techniques, instrumentation for control and data acquisition, data accuracy, productivity, and costs of models and operation. A review of the status of cryogenic wind tunnel projects is also presented.

38545 **(CONF-860841—1) CESAR research in intelligent machines.** Weisbin, C.R. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 37p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86008226.

From World conference on robotics research; Scottsdale, AZ, USA (19 Aug 1986).

The Center for Engineering Systems Advanced Research (CESAR) was established in 1983 as a national center for multidisciplinary, long-range research and development in machine intelligence and advanced control theory for energy-related applications. Intelligent machines of interest here are artificially created operational systems that are capable of autonomous decision making and action. The initial emphasis for research is remote operations, with specific application to dexterous manipulation in unstructured dangerous environments where explosives, toxic chemicals, or radioactivity may be present, or in other environments with significant risk such as coal mining or oceanographic missions. Potential benefits include reduced risk to man in hazardous situations, machine replication of scarce expertise, minimization of human error due to fear or fatigue, and enhanced capability using high resolution sensors and powerful computers. A CESAR goal is to explore the interface between the advanced teleoperation capability of today, and the autonomous machines of the future.

38546 **(CONF-860841—2) Advances in concurrent computers for autonomous robots.** Barhen, J.; Halbert, E.C.; Einstein, J.R. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86008236.

From World conference on robotics research; Scottsdale, AZ, USA (19 Aug 1986).

Some of the most challenging computational requirements facing scientists and engineers today arise within the framework of intelligent autonomous systems. To enable robots to work effectively in real time in an unstructured environment, one needs to solve repeatedly a variety of highly complex mathematical problems such as on-line planning, vision, sensor fusion, navigation, manipulator dynamics and control. The computational requirements of most of these problems fall into the "supercomputer" class, but ultimately one needs to process them "onboard" the autonomous machine. Currently, the only realistic option is VLSI-based concurrent computation. This paper builds on the recent development of a VLSI hypercube supercomputer, to address the fundamental issue of implementing robotic algorithms on actual concurrent hardware. 26 refs.

38547 **(CONF-8604206—1) Glove box design and material.** Coffey, D.E. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 3p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010398.

From US/France workshop on assay instrumentation; Albuquerque, NM, USA (28 Apr 1986).

The glove box design and material used in the Transuranium Processing Plant at Oak Ridge National Laboratory is described. (LM)

38548 **(EUR—9932-EN) Development of a high temperature heat pipe heat exchanger. Final report.** Chaffey, G.; Ralph, J.C.; Wade, C.D. (Department of Energy, London (UK)). 1985. 112p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energy.

Research has been been carried out on sulphur/iodine mixtures for potential use as a new heat pipe fluid for the economically attractive temperature range between about 300°C and 500°C. Only mercury is presently available as a fluid in this range without recourse to hot-side bypass control, to avoid over-pressurisation should cooling be lost. Small percentages of iodine were added to sulphur to reduce its anomalous liquid viscosity to acceptable levels. Heat transfer tests were conducted on silica and metal heat pipes, which indicated stable operation over a range of conditions

up to a maximum axial power density tested of about 1 MW m^{-2} at 400°C vapour temperature. Theoretical estimates, backed by experimental observation, indicate the high concentration of iodine in the vapour phase; whilst vapour pressure measured during actual heat pipe orientation was low and found to lie close to the value for pure sulphur which has a boiling point of 445°C. (orig./GL).

38549 (FNAL-TM—1387) 5-cm, no iron SSC 6-m dipole test program. Mazur, P.O.; Carson, J.A.; Engler, N.H.; Fisk, H.E.; Gonczy, J.D.; Hanft, R.W.; Kuchnir, M.; Mantsch, P.M.; McInturff, A.D.; Nicol, T.H. (Fermi National Accelerator Lab., Batavia, IL (USA)). Feb 1986. Contract AC02-76CH03000. 9p. (CONF-860840—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86008121.

From ICMC/cryogenic engineering conference; Cambridge, MA, USA (12 Aug 1986).

Magnet Design B for the Superconducting Super Collider (SSC) consists of a 5 cm diameter collared coil assembly 12 m long with concentric aluminum thermal shields at 10 K and 80 K, a G-10 post type support system and a minimal iron vacuum vessel located at a large radius from the coil. In order to determine the behavior of such a magnet under both direct current and quenching conditions, a 6 m model was built using Tevatron tooling to produce a 7.6 cm diameter coil. The dc operation demonstrated that the post type suspension has acceptable rigidity. Distortions in the aluminum thermal shield during quench resulted from stresses in the material below the yield values. Temperature increases in the thermal shield due to eddy currents were larger than those calculated using simple assumptions, demonstrating the value of using a model to verify eddy current behavior in complex situations.

38550 (LA-UR—86-1813) Use of fiber optics for perimeter alarms. Schwalm, R.W. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 5p. (CONF-860878—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011240.

From 2. annual symposium and exposition on physical and electronic security; Philadelphia, PA, USA (19 Aug 1986).

Information is presented on the applications of fiber optics in perimeter alarm systems. (JDB)

38551 (LA-UR—86-2112) Simple defense conservative model for mass requirements of hypervelocity projectile impact shields for reentry vehicles. Spillman, G.R. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 19p. (CONF-861091—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012407.

From Hypervelocity impact symposium; San Antonio, TX, USA (21 Oct 1986).

Simple analytical modeling of the physics of interaction of hypervelocity (50 to 100 km/s) projectiles with a bumper shield countermeasure is given. The interaction of projectile and bumper expansion between bumper and underlying vehicle and interaction of bumper/projectile debris cloud with vehicle are examined. Projectile/bumper interactions are treated with ideal gas strongshock and rarefaction equations. Projectile shock decay from bumper rarefaction is approximated by an impulsive shock similarity solution. A crude model for edge rarefactions is derived. Expansion of debris is treated as an expansion superimposed upon a translation with partition derived from a simple inelastic collision model. The effect of nonunity aspect ratio of compressed debris is included. Debris colliding elastically with the vehicle will impart momentum equal to twice the incident normal component. Impulse may be reduced up to a factor of 2 by stagnation radiative losses for small projectiles and large bumper/vehicle stand-off. Impulse can be enhanced by vehicle ablation from radiative coupling, shock heating (inadequate stand-off), or liquid droplet microcratering (inadequate bumper thickness). Estimates of required bumper mass are given for a specific example.

38552 (LA-UR—86-2268) Projectile oscillations in augmented rail guns. Hodgdon, M.L.; Fowler, C.M.; Homan, C.G. (Los Alamos National Lab., NM (USA); Watervliet Arsenal, NY (USA). Benet Weapons Lab.). 1986. Contract W-7405-ENG-36. 7p. (CONF-860703—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012423.

From 4. international conference on megagauss magnetic-field generation and related topics; Santa Fe, NM, USA (14 Jul 1986).

The projectile in an inductive store-powered rail gun, augmented by an external magnetic field, will oscillate under certain conditions. This behavior is easily understood when there is no resistance in the circuit comprising the storage coil, rails and armature. In this case, the flux in the complete circuit is conserved. However, as the projectile moves down the rails, more flux from the augmenting field is picked up. This must be accompanied by a decrease in current in the system to conserve the total flux. At a certain distance down the rails, the current must reverse to conserve the flux, and thus the force on the projectile reverses. This mechanism leads to oscillation of the projectile. An analytic solution is given for the case in which the resistance is zero.

38553 (N—86-21398) Superconducting magnet. Final Report. (Cryomagnetics, Inc., Oak Ridge, TN (USA)). 1985. 11p. (NASA-CR—177848). NTIS, PC A02.

Extensive computer based engineering design effort resulted in optimization of a superconducting magnet design with an average bulk current density of approximately 12KA/cm(2). Twisted, stranded 0.0045 inch diameter NbTi superconductor in a copper matrix was selected. Winding the coil from this bundle facilitated uniform winding of the small diameter wire. Test coils were wound using a first lot of the wire. The actual packing density was measured from these. Interwinding voltage break down tests on the test coils indicated the need for adjustment of the wire insulation on the lot of wire subsequently ordered for construction of the delivered superconducting magnet. Using the actual packing densities from the test coils, a final magnet design, with the required enhancement and field profile, was generated. All mechanical and thermal design parameters were then also fixed. The superconducting magnet was then fabricated and tested. The first test was made with the magnet immersed in liquid helium at 4.2K. The second test was conducted at 2K in vacuum. In the latter test, the magnet was conduction cooled from the mounting flange end.

38554 (SAND—83-7077-Vol.1) Transuranic package transporter. TRUPACT-I. Safety analysis report for packaging (SARP). Volume 1. Grenier, R.M.; Osborne, D.M.; Romesberg, I.E.; Warrant, M.M. (eds.). (Sandia National Labs., Albuquerque, NM (USA); GA Technologies, Inc., San Diego, CA (USA)). May 1986. Contract AC04-76DP00789. 627p. (GA-A—16860-Vol.1; TTC—0338-Vol.1). NTIS, PC A99/MF A01; 1; GPO Dep. File Number DE86011660.

The TRansUranic PACkage Transporter Model I (TRUPACT-I) has been developed for the United States Department of Energy for transporting contact-handled transuranic waste among generating, storage, and/or repository sites. The TRUPACT-I has been designed to meet the requirements of the regulations which govern the design and use of such packagings, namely DOE Order No. 5480.3, 10CFR71, and 49CFR173. This Safety Analysis Report for Packaging (SARP) details the design of TRUPACT-I and summarizes the component testing, scale model testing, and analysis which support an application for its certification.

38555 (SAND—83-7077-Vol.2) Transuranic package transporter. TRUPACT-I. Safety analysis report for packaging (SARP). Appendices to Chapter 2. Volume 2. (Sandia National Labs., Albuquerque, NM (USA); GA Technologies, Inc., San Diego, CA (USA)). May 1986. Contract AC04-76DP00789. 484p. (GA-A—16860-Vol.2; TTC—0338-Vol.2). NTIS, PC A21/MF A01; 1; GPO Dep. File Number DE86011661.

Volume 2 contains the appendices to Chapter 2: Structural Evaluation. (LM)

38556 (SAND—85-2208C) Response of spent LWR fuel to extreme environments. Sandoval, R.P.; Burian, R.J.; Kok, K.D.; DiSalvo, R.; Balmert, M.E.; Freeman-Kelly, R.; Fentiman, A.W. (Sandia National Labs., Albuquerque, NM (USA); Battelle Columbus Labs., OH (USA)). 1986. Contract AC04-76DP00789. 8p. (IAEA-SM—286/92; CONF-860604—23). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011648.

From International symposium on the packaging and transport of radioactive materials (PATRAM '86); Davos, Switzerland (16 Jun 1986).

The research reported in this paper addresses the radiological source term which could arise when irradiated fuel in transport from a commercial light water reactor is exposed to the extreme environments postulated for some transportation accidents, specifically those involving a fire. The release of spent fuel radionuclides to the environment requires a breach of both the cask and the fuel rod cladding. Past research has given significant emphasis to evaluating the response of the shipping cask to mechanical and/or thermal loads from hypothetical accidents. Less consideration has been given to evaluating the response of the fuel rods to these environments. In this paper, the response of the fuel rods to an extreme thermal event was experimentally evaluated and the quantity of solid fuel material that could be released from the fuel rods to the cask cavity was estimated. Briefly, the objectives of this study were as follows: (1) Identify those conditions within a transportation cask which might produce fuel-rod cladding failure, emphasizing conditions associated with fires, and (2) Determine by experiment and analysis the nature of the source term so produced. The release of radionuclides from coolant or deposits on the outer surfaces of the fuel assembly was not addressed in this study. 6 figs., 2 figs.

38557 (SAND—85-2262C) Robotic arm for spray painting on explosive slurry. Duggins, B.; Hill, D. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 10p. (CONF-8603131—1). NTIS, PC A02. File Number DE86005176.

From 4. SME robotic solutions in aerospace manufacturing conference; Orlando, FL, USA (3 Mar 1986).

A robotic arm is used in a laboratory technique developed for spray painting a light-sensitive explosive onto space structures. The technique was created to simulate an impulsive load experienced by exposure of a reentry vehicle to a hostile nuclear encounter which may affect the structure's ability to perform the design function. This paper explains the technique, including robot control, spray appplication and deposition, load diagnostics and safety considerations.

38558 (SAND—86-2061C) Optimal descending, hypersonic turn to heading. Eisler, G.R.; Hull, D.G. (Texas Univ., Austin (USA)). 1986. Contract AC04-76DP00789. 15p. (CONF-860882—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010989.

From Atmospheric flight mechanics conference; Williamsburg, VA, USA (18 Aug 1986).

Approximations are made to the point-mass equations of motion for flight within the atmosphere. Optimal controls are formulated for a reentry vehicle to execute a maximum-terminal-velocity turn to a specified heading while executing steep, descent trajectories. A Newton scheme is used repetitively to solve a nonlinear algebraic system for two parameters in the control equations to provide the on-line guidance. Trajectory comparisons from the repetitive solution of the optimal control problem, pure numerical optimization, and simulation of sample-data guidance show good agreement, if the atmospheric model is accurate.

38559 (SVF—201) Frictionally fixed district heating pipeline. Field measurements at Lund. Part 2. Olofsson, D.; Molin, J.; Bergendorff, K. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Aug 1985. 30p. (In Swedish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752152.

The essential variable on dimensioning of the line is the coefficient of friction between pipe and ballast. The magnitude of this coefficient has been measured at the first stage during three years and now during two years. The length of the measured pipeline was 1.7 km. The lower limit of the coefficient was determined to be μ equals 0.15 when calculating maximum movements for frictional attachment. For frictionally restrained installations the value μ equals 0 is recommended with μ equals 0.4 for the determination of frictional length.

38560 (UCRL—93482) New electromagnetic effects associated with cavity-backed apertures. Ziolkowski, R.W. (Lawrence Livermore National Lab., CA (USA)). 1986. Contract W-7405-ENG-48. 6p. (CONF-860849—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86008768.

From URSI international symposium on electromagnetic theory in Budapest; Budapest, Hungary (25 Aug 1986).

A number of canonical problems that describe coupling through apertures into enclosed regions have been solved. The scattering data generated by these cavity-backed aperture (CBA) solutions share a common property: they are dominated by resonance features closely connected to the presence of the cavity. The behavior of these CBA resonance features will be described for variations in frequencies, angles of incidence, look angles, aperture sizes, and interior object characteristics. In particular, it will be demonstrated that standard bistatic cross-sections contain information about the interior of the cavity.

38561 (UCRL—93825) Flat-plate experiments on magnetically accelerated metal liners. Steinberg, D.J.; Shearer, J.W. (Lawrence Livermore National Lab., CA (USA)). Jul 1986. Contract W-7405-ENG-48. 10p. (CONF-860703—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012357.

From 4. international conference on megagauss magnetic-field generation and related topics; Santa Fe, NM, USA (14 Jul 1986).

We summarize several years work aimed at utilizing high magnetic fields, produced by high-explosive flux-compression generators, for accelerating to high velocity a 1-cm-long metal liner in flat-plate geometry. The liner did not remain intact, even in a vaporized state, for more than a few centimeters of travel between two parallel conducting walls. We believe that liner bowing from pressure of the magnetic field prior to melt causes the liner to move to the walls rather than straight ahead between walls.

38562 (UCRL—94541) Evaluation and testing of totally encapsulating chemical protective suits. Johnson, J.S. (Lawrence Livermore National Lab., CA (USA)). 1 Jun 1986. Contract W-7405-ENG-48. 10p. (CONF-860695—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011635.

From HazMat '86: hazardous materials management conference and exhibition; Atlantic City, NJ, USA (2 Jun 1986).

This report describes and discusses means for testing the resistance of totally encapsulating chemical protective suits against chemical vapor penetration. (ACK)

38563 Self-biased Josephson junctions. (Ames Laboratory and Department of Physics, Iowa State University, Ames, Iowa 50011). *Journal of Applied Physics;* **60**: No. 3, 1214-1216(1 Aug 1986).

Transport currents in one leg of a cross strip superconducting-normal metal-superconducting Josephson junction have been used to bias the current-voltage characteristics of the junction, and hence use the junction as a control element. The bias current creates a magnetic field in the junction, which in turn modulates the Josephson currents. As the bias current causes successive flux quanta to enter the junction, the Josephson critical current shows current-voltage curves similar to the resistively shunted junction model and a normal Fraunhofer pattern. Values of the bias are relatively small because the junctions are so thick. A detailed study of the junction voltage as a function of bias current shows reentrant superconductivity as successive vortices enter the junction.

38564 Latch assembly. Fredrickson, J.R.; Harper, W.H.; Perez, R. (to Dept. of Energy, Washington, DC). US Patent 4,586,740. 6 May 1986. Filed date 14 Jan 1985. vp.

A latch assembly is described for releasably securing an article in an apparatus housing having a side wall and a bottom wall comprising: a latching cam mounted on the housing wall for pivot-

ed movement between an operative position and an inoperative position wherein the cam is triangular in side elevation and formed with a first portion of solid thickness and a second bifurcated portion defining laterally spaced legs, means biasing the cam into the operative position projecting into the interior of the housing. The cam is urged into the inoperative position by the article upon entry thereof into the housing, means maintaining the cam in the inoperative position upon passage of the article therepast into a final position seated on the housing bottom wall. The biasing means snapp the cam into latching engagement against the article upon displacement of the maintaining means relative to the cam to secure the article in place against the housing bottom wall and including a pivot pin mounted on the housing wall and extending through the cam first portion, means on the second portion for supporting a roller between the legs, and means on the second portion spaced from the supporting means for mounting a spring biased piston thereon.

38565 **Radiofrequency amplifier based on a DC superconducting quantum interference device.** Martinis, J.M.; Hilbert, C.; Clarke, J. (to Dept. of Energy, Washington, DC). US Patent 4,585,999. 29 Apr 1986. Filed date 27 Apr 1984. vp.

A method is described of amplifying a radiofrequency signal consisting of: disposing a single symmetrically biased dc SQUID and an input coil within a superconducting shield, the dc SQUID having a superconducting ring interrupted by two shunted Josephson junctions, and the input coil being inductively coupled solely to the ring of the single SQUID, establishing a constant magnetic flux threading the SQUID ring, applying the radiofrequency signal to the input coil from outside of the superconducting shield, obtaining an amplified radiofrequency signal solely from across the ring of the single SQUID, transmitting the amplified radiofrequency signal from across the SQUID ring to the outside of the superconducting shield.

38566 **Implicit finite element structural dynamic formulation for long-duration accidents in reactor piping systems.** Wang, C.Y. (Argonne National Lab., IL, USA. Reactor Analysis and Safety Div.). pp 55-60 of Transactions of the 8. international conference on structural mechanics in reactor technology. Vol. B. Computer methods for structural analysis. Stalpaert, J. (ed.). Amsterdam, Netherlands; North-Holland (1985). (CONF-850809—; EUR—10001-DE/EN/FR).

From 8. international conference on structural mechanics in reactor technology; Brussels, Belgium (19 Aug 1985).

This paper describes an implicit three-dimensional finite-element formulation for the structural analysis of reactor-piping system. The numerical algorithm considers hoop, flexural, axial, and torsion modes of the piping structures. It is unconditionally stable and can be used for calculation of piping response under static or long-duration dynamic loads. The method uses a predictor-corrector, successive iterative scheme which satisfies the equilibrium equations. A set of stiffness equations representing the discretized equations of motion are derived to predict the displacement increments. The calculated displacement increments are then used to correct the element nodal forces. The algorithm is fairly general, and is capable of treating large displacements and elastic-plastic materials with thermal and strain-rate effects.

38567 **Versatile zone refiner for liquids and low-melting solids.** Martin, C.B.; Martin, R.J.; Nasir, P.; Wieczorek, S.A.; Romanco, W.R.; Sivaraman, A.; Kragas, T.; Kobayashi, R. (Rice Univ., Houston, TX). *Review of Scientific Instruments;* **55**: No. 11, 1831-1833(Nov 1984).

A versatile zone refining apparatus which employs liquid nitrogen as the refrigerant to maintain the compound to be purified in the solid state while appropriately spaced resistance heaters generate the moving liquid zones to purify compounds whose melting point lies between 200 and 350 K is described. As much as 0.750 kg of substance can be purified at one time to a purity better than 99.95 mole %. 11 references, 4 figures, 1 table.

38568 **Modeling antennas near to and penetrating a lossy interface.** Burke, G.J.; Miller, E.K. (Lawrence Livermore National Lab., CA). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Antennas and Propagation;* **AP-32**: No. 10, 1040-1049(Oct 1984). Contract W-7405-ENG-48.

A technique for modeling wire objects interacting across or penetrating the planar interface which separates two half-spaces is described. The moment-method treatment is employed, based on the thin wire approximation to the electric-field integral equation, with the effect of the interface included via the Sommerfield integrals. The computation time associated with evaluating the latter is substantially shortened by using an interpolation-based technique plus asymptotic field expressions. Although developed specifically for the wire problem, the procedure is also applicable, with slight modification, to modeling surface objects as well. Special care is taken to account for the charge discontinuity that occurs at the point a wire penetrates the interface. Example calculations are shown for a monopole antenna driven against ground stakes and simple ground screens, the fields of buried objects, and a simple electromagnetic pulse (EMP) simulator. 14 references, 11 figures.

38569 **Buffeting of a slender circular beam in axial turbulent flows.** Lin, W.H. (Argonne National Lab., IL). *AIAA (American Institute of Aeronautics and Astronautics) Journal;* **22**: No. 5, 690-695(May 1984).

From 24. structures, structural dynamics and materials conference; Lake Tahoe, NV, USA (2-4 May 1983).

This paper deals with the buffeting of a slender, circular, flexible beam-rod in an axial turbulent flow. The principal excitation mechanisms are the turbulent wall pressure fluctuations and the motion-dependent (self-excited) aerodynamic force caused by the beam motion. On the assumption that the turbulent wall pressure fluctuations are independent of the beam motion, a linear forced-vibration model is used to determine the buffeting response of the beam and to investigate the length scale effects of turbulences on the beam buffeting. Transverse buffeting of the beam in an axial turbulent flow depends largely on the ratio of the longitudinal scale of the turbulences to the bending wavelength of the beam and on the ratio of the circumferential scale of the turbulences to the radius of the beam. The spectra and the mean square values of the buffeting displacement of the beam become vanishingly small, both when either of these ratios is very small ($<10^{-2}$) and when the latter is very large ($>10^{2}$). When the former ratio is very large the first mode of the buffeting is dominant and other modes are less apparent, especially the high-frequency modes. 27 references, 3 figures.

38570 **Novel optical pin using microballons.** Benjamin, R.F. (Los Alamos National Lab., NM). *Materials Research Society Symposia Proceedings;* **22**: 299-300(1984).

The author describes the design, fabrication and application of an optical probe for detecting a shock front or moving surface. The probe is a gas-filled microballoon affixed to an optical fiber. The probe has significant technical and economic advantages over other methods. 6 references.

38571 **Shellside waterflow pressure drop distribution measurements in an industrial-sized test heat exchanger.** Halle, H.; Chenoweth, J.M.; Wambsganss, M.W. (Argonne National Lab., IL). *HTD [Publication] (American Society of Mechanical Engineers);* **36**: 37-48([1986]).

Throughout the life of a heat exchanger, a significant part of the operating cost arises from pumping the heat transfer fluids through and past the tubes. The pumping power requirement is continuous and depends directly upon the magnitude of the pressure losses. Thus, in order to select an optimum heat exchanger design, it is as important to be able to predict pressure drop accurately as it is to predict heat transfer. This paper presents experimental measurements of the shellside pressure drop for 24 different segmentally-baffled bundle configurations in a 0.6-m (24-in.) diameter by 3.7-m (12-ft) long shell with single inlet and outlet nozzles. Both plain and finned tubes, nominally 19-mm (0.75-in.) outside diameter, were arranged on equilateral triangular, square, rotated triangular, and rotated square tubefield layouts with a tube pitch-to-

diameter ratio of 1.25. Isothermal water tests for a range of Reynolds numbers from 7000 to 100,000 were run to measure overall as well as incremental pressure drops across sections of the exchanger. The experimental results are given and correlated with a pressure drop versus flowrate relationship. 10 references, 9 figures, 6 tables.

4203 Lasers

REFER ALSO TO CITATION(S) 37689, 38430, 38435, 38437, 38455, 39299, 39410, 39415, 39421, 39422

38572 (AD-A—165626/3/XAB) Master oscillator and diagnostic unit design. Final report, 7 May 1984-8 January 1985. Way, F.C.; Schaack, D.F. (Spectron Development Labs., Inc., Albuquerque, NM (USA)). Jan 1986. 72p. NTIS, PC A04/MF A01.

This report describes the design and development of a dye laser operating at 353 nm and an associated beam-diagnostics unit capable of measuring uv phase, intensity and energy. The dye laser consists of a flashlamp pumped oscillator, including spatial and temporal mode selectors and a wavelength tuning device. The output of the oscillator at 706 nm is amplified by a flashlamp-pumped dye amplifier. The resulting output is frequency doubled to 353 nm via a second harmonic generator (SHG). A pulse slicer is incorporated prior to the SHG to allow pulsewidth selectivity. The diagnostic unit was designed and fabricated to be versatile and rugged. Near-field phase and intensity and far-field intensity are photographically recorded, and energy and pulsewidth are monitored by the device.

38573 (AD-A—165641/2/XAB) Slab geometry laser. Part 2. Thermal effects in a finite slab. Kane, T.J.; Eggleston, J.M.; Byer, R.L. (Stanford Univ., CA (USA)). Aug 1985. 17p. NTIS, PC A02/MF A01.

This paper presents two methods for calculating the thermally induced stress, focusing, and depolarization in a pumped zigzag-slab solid-state laser. A computer program capable of detailed calculations of thermal effects in the general case is described. An approximate analysis of slab thermal effects in many cases allows calculation of these effects without use of the computer model directly. The analysis predicts that slabs of square cross section can be designed to have low depolarization and thermal focusing compared to Nd:YAG laser rods.

38574 (AD-A—165709/7/XAB) Deactivation of HF(v = 3) by water. Technical report. Bott, J.F. (Aerospace Corp., El Segundo, CA (USA). Laboratory Operations). 31 Dec 1985. 13p. (TR—0086(6603)-1). NTIS, PC A02/MF A01.

Water is often present as an impurity in HF chemical laser systems and can affect laser performance because of the large HF(1) - H_2O deactivation rate coefficient. Diatomic molecules have been found to deactivate the higher vibrational levels of HF(v) with rate coefficients that scale with v as v /sup n/ where n = 2.7 when the deactivation process is exothermic. This scaling does not hold for HF(v) - H_2 collisions in which the primary deactivation process is an endothermic V-V transfer with the endothermicity increasing with v. The room temperature (T = 295 K) deactivation rate of HF (v = 3) by H_2O was measured to be faster than the deactivation rate of HF(v = 1) by H_2O by a factor of 3.9. On the basis of a previously reported measurement of the HF(v = 1) - H_2O rate coefficient, the deactivation rate coefficient of HF(v = 3) by H2O is estimated to be 16 μsec/Torr, which is a factor of 3 faster than the hard-sphere collision rate. The theoretical implication of this fast-rate coefficient are reviewed. Keywords: Chemical kinetics; Vibrational deactivation.

38575 (AD-A—165734/5/XAB) Radiationless deactivation of low-field chromium complexes in solids. Final technical report, 31 August 1982-31 December 1985. Bartram, R.H. (Connecticut Univ., Storrs (USA). Dept. of Physics). 20 Feb 1986. 27p. NTIS, PC A03/MF A01.

Thermal quenching of fluorescence is a major loss mechanism that may impede the performance of tunable solid-state lasers, but whose impact is difficult to assess a-priori. The object of the reported investigation was to achieve a quantitative understanding of the factors that control this process, with the ultimate goal of formulating design criteria for tunable solid-state laser materials. The temperature dependence of chromium photoluminescence spectra and lifetimes was measured in ordered perovskite (Cs_2NaYCl_6, K_2NaScF_6 and K_2NaGaF_6) low-crystal-field host crystals. After the failure of linear-coupling models was demonstrated, a successful theoretical model was proposed in which fluorescence quenching is mediated by quadratic coupling to asymmetric modes of vibration. Parameters of the model are constrained by empirical spectral information, and radiationless transition rates are calculated by numerical line-shape simulation. Both semi-empirical (INDO) and ab-initio molecular-orbital cluster calculations were performed in conjunction with lattice-statics calculations in a continuing effort to refine this quenching model. Photoluminescence spectra and lifetimes, measured as functions of temperature and pressure in a diamond-anvil cell, revealed a pressure-induced transition from broad-band fluorescence to narrow-band phosphorescence; i.e., from low-crystal-field to high-crystal-field behavior.

38576 (AD-A—165807/9/XAB) Atomic hydrogen maser investigations of hydrogen atom interactions from 4 to 12 K. Final report, 1 March 1980-28 February 1985. Crampton, S.B. (Williams Coll., Williamstown, MA (USA). Dept. of Physics and Astronomy). 24 Mar 1986. 18p. NTIS, PC A02/MF A01.

Techniques developed during previous studies of the ground-state hyperfine resonance of hydrogen atoms intermittently adsorbed on molecular hydrogen surfaces were used to develop a cryogenic atomic-hydrogen maser using a 5 K state-selected H-atom beam and solid-neon storage surfaces near 10 K temperature. The physical parameters affecting the use of such a device for frequency metrology and precision measurements of atomic parameters were determined.

38577 (AD-A—165850/9/XAB) Light-weight hydrogen maser. Final report, March 1979-July 1984. Peters, H.E. (Sigma Tau Standards Corp., Tuscaloosa, AL (USA)). Dec 1985. 22p. NTIS, PC A02/MF A01.

Based upon a new approach to cavity-resonator and atom-storage assembly design, experimental work was undertaken to develop a much smaller and lighter hydrogen-maser frequency standard. An operational prototype maser of light weight and small size resulted, but the new cavity and bulb design did not result in improved stability. Upon knowledge gained in this program, further work funded by other government agencies has resulted in successful hydrogen maser oscillators having unprecedent frequency stability.

38578 (LA-UR—86-2014) Metal reflectors in the EUV. Scott, M.L.; Arendt, P.N.; Cameron, B.J.; Cordi, R.C.; Newnam, B.; Windt, D.; Cash, W. (Los Alamos National Lab., NM (USA); Colorado Univ., Boulder (USA)). 1986. Contract W-7405-ENG-36. 9p. (CONF-860880—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012372.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

High reflectance mirrors are difficult to achieve in the extreme ultraviolet (EUV) and we have found that one of the principle reasons is the presence of contamination layers on the surface of these reflectors. We have begun a study of these contamination layers that form even in an ultra-high vacuum (uhv) system. Our initial study consists of monitoring the growth of these contamination layers on various metal surfaces utilizing Auger electron spectroscopy (AES). A principal conclusion from this work is that the rate of growth of oxide and carbon contamination layers on Al, Si, and Rh is greatly enhanced if the ion gauges and Auger filaments are operating. Reflectance measurements on Rh at 11.3 nm also indicate the presence of significant carbon contamination on samples exposed to air. In addition, we find that oxide growth on Ag is negligible and carbon contamination is minimal. 12 figs.

38579 **(LA-UR—86-2254) Los Alamos x-ray characterization facilities for plasma diagnostics.** Day, R.H.; Blake, R.L.; Stradling, G.L.; Trela, W.J.; Bartlett, R.J. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 11p. (CONF-860880—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012427.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

A summary is given of characteristics of x-ray sources used by Los Alamos National Laboratory to calibrate various x-ray diagnostic packages and components. Included are D.C. sources in electron impact and fluorescence modes, a pulsed laser source for soft x rays with 100 ps time resolution, Febetron pulsed electron impact sources, and both EUV and x-ray synchrotron beamlines.

38580 **(N—86-21402) Growth and evaluation of $AgGaS_2$ and $AgGaSe_2$ for infrared nonlinear applications. Final Technical Report, 1 February 1982-31 December 1985.** Byer, R.L.; Feigelson, R.S. (Stanford Univ., CA (USA)). Feb 1986. 30p. NTIS, PC A03/MF A01.

Significant advances were made in the growth technology of silver thiogallate ($AgGaS_2$) and silver selenogallate ($AgGaSe_2$). High efficiency harmonic generation of carbon dioxide laser radiation and tunable infrared parametric oscillation were demonstrated using these materials. Nonliner frequency conversion in the infrared was limited by the optical properties and the size of the available nonlinear materials. The development of these materials has reduced some of the limitations and generated wide interest. The continued development and application of $AgGaS_2$ and $AgGaSe_2$ now appears assured.

38581 **(PFC/JA—86-33) Kinetic analysis of the sideband instability in a helical wiggler free laser for electrons trapped near the bottom of the ponderomotive potential.** Davidson, R.C.; Wurtele, J.W.; Aamodt, R.E. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). May 1986. Contract W-7405-ENG-36;AC02-78ET51013. 45p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86011874.

A kinetic formalism based on the Vlasov-Maxwell equations is used to investigate properties of the sideband instability for a tenuous, relativistic electron beam propagating through a constant-amplitude helical wiggler magnetic field (wavelength $\lambda_0 = 2\pi/k_0$, and normalized amplitude a/sub w/ = e circumflex B/sub w/mc^2k_0). The analysis is carried out for perturbations about an equilibrium BGK state in which the distribution of beam electrons G/sub s/(γ') and the wiggler magnetic field coexist in quasi-steady equilibrium with a finite-amplitude, circularly polarized, primary electromagnetic wave (ω/sub s/,k/sub s/) with normalized amplitude a/sub s/ = e circumflex B/sub s//mc^2k/sub s/. Particular emphasis is placed on calculating detailed properties of the sideband instability for the case where a uniform distribution of trapped electrons is localized near the bottom of the ponderomotive potential moving with velocity v/sub p/ = ω/sub s//(k/sub s/ + k_0) relative to the laboratory frame.

38582 **(SAND—86-1011C) Reactor-pumped laser experiments in the Sandia SPR-III facility.** McArthur, D.A.; Hays, G.N.; Neal, D.R.; Pickard, P.S.; Rice, J.K. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 15p. (CONF-860420—4). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012163.

From Fast burst reactor workshop; Albuquerque, NM, USA (8 Apr 1986).

Experiments on the excitation of short-wavelength gas lasers have recently been performed in the central cavity of the Sandia fast burst reactor SPR-III. Small-signal gain coefficients ~0.7%/cm were measured in XeF laser mixtures excited with either the ^{3}He(n,p)T reaction or with fission fragments emitted from the wall of the laser cell. Specialized apparatus helpful in performing these measurements is described. Preliminary experiments included measurement of radiation effects on cell window materials and laser mirrors, and measurement of energy deposition in the laser gas as a function of time for various cell geometries and polyethylene moderator thicknesses. The optical distortion of the laser medium by the energy deposition process was much more severe for fission fragment excitation. Fluorescence spectra were also measured for XeF laser mixtures with an optical multichannel analyzer, and these spectra were consistent with the XeF gain measurements.

38583 **Discharge constriction, photodetachment, and ionization instabilities in electron-beam-sustained discharge excimer lasers.** (Spectra Technology Inc. (Formerly Mathematical Sciences Northwest), 2755 Northup Way, Bellevue, Washington 98004). *Journal of Applied Physics;* 60: No. 3, 904-914(1 Aug 1986).

Rare gas—halogen excimer lasers excited by electron-beam-sustained discharges (EBSD) will operate stably for only a limited length of time (hundreds of nanoseconds to a few microseconds). In this paper, results from a multidimensional model for an EBSD KrF laser are used to study various aspects of discharge ionization and geometric stability, and the relationship between the two. We examine the effects of photodetachment of electrons from the halogen negative ion, of circuit response, and of nonuniform e-italic-beam power deposition upon the onset of discharge instabilities. We find that both spontaneous emission from KrF^* and laser oscillation resulting in photodetachment of electrons from F^- can initiate an ionization instability. By operating with high impedance electrical circuits, the tendency towards instabilities by this effect can be reduced. We also find that the spatial uniformity of the e-italic-beam power deposition is directly correlated with both the rate of discharge constriction and the time at which the discharge suffers an ionization instability.

38584 **Study of Mo-, Au-, and Ni-implanted molybdenum laser mirrors by multiple angle of incidence spectroscopic ellipsometry.** Snyder, P.G.; Rost, M.C.; Bu-Abbud, G.H.; Oh, J.; Woollam, J.A.; Poker, D.; Aspnes, D.E.; Ingram, D.; Pronko, P. (Department of Electrical Engineering, University of Nebraska, Lincoln, Nebraska 68588-0511). *Journal of Applied Physics;* 60: No. 2, 779-788(15 Jul 1986). Contract AC05-84OR21400.

Multiple angle of incidence spectroscopic ellipsometric data show that implantation of 150-keV molybdenum ions into polished molybdenum laser mirrors causes microscopic surface smoothing, and that most of the microscopic roughness is removed by a fluence of 5 x 10^{15} cm^{-2}. Implantation of Au at 1 MeV significantly increases the microscopic roughness, and also changes the bulk optical properties. 3-MeV Ni ion implantation causes only small changes in the surface and bulk properties. A dielectric film, probably a hydrocarbon, is found to condense on the mirrors in a laboratory atmosphere.

38585 **Fracture of solid state laser slabs.** Marion, J.E. (Lawrence Livermore National Laboratory, University of California, P. O. Box 5508, L-490, Livermore, California 94550). *Journal of Applied Physics;* 60: No. 1, 69-77(1 Jul 1986). Contract W-7405-ENG-48.

Fracture due to thermal stress limits the power output potential of modern, high average power slab lasers. Here the criteria for slab fracture and the nature of the surface flaws which constitute the strength-controlling defects are reviewed. Specific fracture data for gadolinium scandium gallium garnet and LHG-5 phosphate glass with different surface finishes are evaluated in the context of assigning appropriate slab operating parameters using Wiebull statistics. These examples illustrate both the danger of design using brittle components without adequate fracture testing, and the inadequacy of design methods which use a fixed safety factor, for this class of materials. Further consideration reveals that operation of slab lasers in contact with an aqueous coolant may lead to strength degradation with time. Finally, the evolution of the failure process in which a characteristic midplane crack forms is outlined, and the pertinent parameters for avoiding slab fracture are identified.

38586 **Possibility of obtaining coherent radiation from a solid state undulator.** Bogacz, S.A.; Ketterson, J.B. (Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60201; Materials Science and Technology Division, Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Applied Physics;* 60: No. 1, 177-188(1 Jul 1986). Contract W-31-109-ENG-38.

The idea of using a crystal lattice or a superlattice as an undulator for a free electron laser is explored. A purely classical treatment of relativistic positrons channeling through the proposed structure is performed in a self-consistent fashion involving the wave equation for the radiating electromagnetic field and the kinetic equation for the positron distribution function. The (positive) gain coefficient for a forward radiating field is obtained in closed form. Matching the Kumakhov channeling resonance to the undulator frequency further enhances the gain. This result, combined with a feedback mechanism arising from Bragg diffraction within the basic crystal lattice, leads to an instability of the radiation inside the crystal. A simple threshold condition involving the atomic scattering factor and the net gain is formulated. Finally, a numerical estimate of the Kumakhov-enhanced gain coefficient is made for the (110) planar channeling in a strain-modulated Si superlattice.

38587 **Laser beam profile measurement by photothermal deflection technique.** (University of Arkansas, Physics Department, Fayetteville, Arkansas 72701). *Applied Optics;* **25**: No. 11, 1738-1741(1 Jun 1986).

Laser beam profiles are measured using the photothermal deflection technique in an absorbing gas. The method is based on the change of the index of refraction due to laser-radiation heating. (AIP)

38588 **Parametric study of a pulsed xenon-ion laser.** (Indian Institute of Technology, Physics Department, Kanpur 208 016, India). *Applied Optics;* **25**: No. 11, 1854-1856(1 Jun 1986).

Detailed results of the parametric behavior of the prominent seven visible transitions in a pulsed Xe IV laser are reported. The various laser parameters considered are gas pressure, excitation voltage, energy storage capacitor, and the diameter and length of the plasma tube. Based on our results we believe that lasing is favored in larger bore tubes as wall collisions play a significant role in quenching the laser action.

38589 **Short wavelength laser.** Hagelstein, P.L. (to Dept. of Energy, Washington, DC). US Patent 4,589,113. 13 May 1986. Filed date 25 Jun 1984. vp.

A method is described for providing an electron collisionally-excited single pass amplified spontaneous emission short wavelength laser gain medium that laser amplifies 3p-3s transition EUV or soft X-ray radiation along an approximately linear path, the method comprising the step of: producing a multiplicity of plasmas arrayed in two separated and alternately staggered parallel arrays disposed along the approximately linear path, with the plasma having an approximately exponential decaying electron density gradient extending perpendicularly inward toward the approximately linear path.

38590 **(N—86-21815) Infrared diagnosis using liquid crystal detectors.** Hugenschmidt, M.; Vollrath, K. (National Aeronautics and Space Administration, Washington, DC (USA)). Feb 1986. Translated Infrarotdiagnostik mit Hilfe von Fluessigkristalldetektorn, BMVG-FBWT—73-16, West German Ministry of Defense and the Institute Franco-Allemand de Recherches, St. Louis, France and Weil, West Germany, 1-21(1972). (NASA-TM—77999; BMVG-FBWT—73-16). 19p. NTIS, PC A02/MF A01.

The possible uses of pulsed carbon dioxide lasers for analysis of plasmas and flows need appropriate infrared image converters. Emphasis was placed on liquid crystal detectors and their operational modes. Performance characterstics and selection criteria, such as high sensitivity, short reaction time, and high spatial resolution are discussed.

38591 **Dynamic criticality sensitivity of a nuclear-pumped laser.** Kunze, J.F.; Prelas, M.A.; Gu, G.X. (Univ. of Missouri, Columbia). *Transactions of the American Nuclear Society;* **50**: 574(Nov 1985). (CONF-851115—).

From American Nuclear Society winter meeting; San Francisco, CA, USA (10 Nov 1985).

The nuclear-pumped lasers, using the concept of an aerosol reactor energy conversion (AREC) system, are proposed as a means of achieving high energy conversion efficiencies (thus minimizing waste heat rejection requirements) and to achieve the high power densities needed within a flowing gas aerosol core, thus avoiding the high-temperature materials problems of the conventional solid-fueled driver reactor concepts. The component experimental studies done over a decade ago with the gas core concept have been applied to the fission driven laser concept. Though these flowing gas simulation studies were then designed to examine the feasibility of the large high-power steady-state gas-core reactor concept (intended for space nuclear propulsion or for magnetohydrodynamics applications on earth), the bulk of these experiments were on 18-in.-diam systems, and therefore of the order of magnitude of the unit cell of a nuclear-pumped laser system.

38592 **Pressure dependence of Al/sub x/Ga/sub 1 - x/As light emitting diodes near the direct-indirect transition.** Kaliski, R.W.; Epler, J.E.; Holonyak, N. Jr.; Peanasky, M.J.; Herrmannsfeldt, G.A.; Drickamer, H.G.; Tsai, M.J.; Camras, M.D.; Kellert, F.G.; Wu, C.H.; Craford, M.G. (Univ. of Illinois, Urbana). *Journal of Applied Physics;* **57**: No. 5, 1734-1738(1 Mar 1985). Contract AC02-76ER01198.

High-pressure studies on high quality Al/sub x/Ga/sub 1-x/As double heterostructure light emitting diodes (LEDs) grown by liquid phase epitaxy (LPE) are presented. The Al/sub x/Ga/sub 1 - x/As active region varies in composition from x~0.25 to x~0.53, i.e., through the important region of the direct-indirect crossover (x identical with x/sub c/≈0.45). The pressure coefficient of the Γ conduction band is observed to decrease (~ 1 MeV/kbar for x~0.25 to x~0.53) with increasing Al concentration, which is in accord with alloy disorder and band-edge bowing. Indirect-gap (Chi) recombination radiation of significant intensity is observed and provides evidence for the high quality LPE diodes . High-pressure measurements, and the corresponding increase in energy of the direct band edge and decrease in the indirect band edge, show that the light emission is a strong function of the carrier distribution in the Γ and Chi conduction-band minima. Comparison LEDs fabricated from a crystal (x~0.37) grown by metalorganic chemical vapor deposition exhibit nearly similar behavior as the LPE LEDs with application of pressure but with an order of magnitude lower light emission. 9 references, 6 figures, 1 table.

38593 **Optically pumped NO ($A^2u \rightarrow hi^2\pi$) ultraviolet laser.** Burrows, M.D.; Baughcum, S.L.; Oldenborg, R.C. (Air Force Weapons Lab./ARDD, Kirtland AFB, NM). *Applied Physics Letters;* **46**: No. 1, 22-24(1 Jan 1985).

Lasing action on the (0,1) and (0,2) γ bands of NO at 237 and 248 nm, respectively, has been obtained by longitudinal pumping of 0.5 Torr of NO on the (0,0) γ-band transition at 227 nm. Typical output pulse energies were 13 μJ at an intrinsic energy conversion efficiency of approximately 15%.

38594 **The advantage of foams in plasma-implosion-driven X-ray laser targets.** Hussey, T.W.; Allshouse, G.O.; Matzen, M.K. (Sandia National Labs., Albuquerque, NM). pp 5R-6 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC04-76DP00789.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The use of electromagnetically imploded gas puffs to pump x-ray lasers is being pursued at a number of laboratories. The ability to efficiently implode an annular gas puff and to extract a significant component of kilovolt pump radiation is well established. What is less certain is the ability to maintain an appropriately shaped channel of lasant at the proper density, temperature, and uniformity. Maxon, et al. have proposed a system consisting of a gas puff stagnating on the outer of two concentric cylinders. The purpose of this two-cylinder design is to convert gas puff kinetic energy to thermal energy, while at the same time maintaining the integrity of the lasant channel. The outer cylinder of their design requires a foam annulus extending from a radius of .18 cm to .2 cm. Such a system will be difficult to fabricate and the alternative is to replace the foam with a foil. The authors have performed calculations with LASNEX and with TITAN to compare the dynamics of stagnating gas puffs against foil cylinders and foam annuli. They find that the best conditions in terms of temperature, density, and

uniformity for lasing are obtained with foam annuli. Furthermore, they find that foams that are somewhat thicker than Maxon proposed may offer improved uniformity with little penalty in lasant temperature or in pump radiation intensity.

38595 **Calculation of cavity supermodes for diode laser arrays.** Hadley, G.R. (Sandia National Labs., Fluid Mechanics and Heat Transfer Div., Albuquerque, NM). pp 126 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The authors present a numerical method for solution of the cavity modes of a multichannel array of laser diodes. Whereas other numerical studies have concentrated on the calculation of profiles transverse to the cavity axis, the emphasis in this work is on the effects on the axial profiles of saturable gain and the reflected (left-going) wave. The analysis is based on coupled-mode theory in which wave overlap between channels is expressed in terms of a coupling coefficient. The calculational method allows the investigation of cavity modes for a given device length and facet reflectivities. These modes are in general different from those obtained by solving linear waveguide equations. The coupled-mode formalism used here leads to propagation equations for the axially dependent electric-field amplitudes. These equations, which include gain saturation due to both the forward-going and reflected waves, are solved numerically together with the appropriate reflecting boundary conditions at each facet. Solution proceeds via a shooting method, whereby an initial guess is made for the electric fields of both waves at one end of the cavity. The field equations are then integrated to the other end, and the initial guess is modified until boundary conditions at that end are satisfied.

38596 **Technical and historical overview of the study at Lawrence Livermore National Laboratory of porous antireflection coatings.** Milam, D. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA 94550). pp 19-27 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—). Contract W-7405-ENG-48.

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The testing program leading to selection of antireflection coatings for the NOVA laser is reviewed. Limiting problems that prevented use of some coating technologies are described, and estimates are made of the current value of pursuing solutions to those problems.

38597 **Grazing Incidence Beam Expander.** Akkapeddi, P.R.; Glenn, P.; Fuschetto, A.; Appert, Q.; Viswanathan, V.K. (Perkin-Elmer Corp., Danbury, CT 06810). pp 94-103 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

A Grazing Incidence Beam Expander (GIBE) telescope is being designed and fabricated to be used as an equivalent end mirror in a long laser resonator cavity. The design requirements for this GIBE flow down from a generic Free Electrom Laser (FEL) resonator. The nature of the FEL gain volume (a thin, pencil-like, on-axis region) dictates that the output beam be very small. Such a thin beam with the power levels characteristic of FELs would have to travel many meters before expanding enough to allow reflection from cooled mirrors. A GIBE, on the other hand, would allow placing these optics closer to the gain region and thus reduces the cavity lengths substantially. Results are presented relating to optical and mechanical design, alignment sensitivity analysis, radius of curvature analysis, laser cavity stability analysis of a linear stable concentric laser cavity with a GIBE. Fabrication details of the GIBE are also given.

38598 **Strained-Layer-Superlattice optoelectronic devices.** Chaffin, R.J. (Device Research Dept., Sandia National Labs., Albuquerque, NM 87185). pp 160-167 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The Strained-Layer-Superlattice (SLS) is an important new class of semiconductor material. This new semiconductor material has many novel and tailorable properties that can be used to make new or improved optoelectronic (OE) devices. At Sandia National Laboratoriess the authors have fabricated and tested Light-Emitting-Diodes (LED's), Lasers, Detectors and other OE SLS devices. Data is presented on these devices. Novel infrared and photovoltaic device concepts are also described.

38599 **Resonator optical designs for free-electron lasers.** Viswanathan, V.K.; Saxman, A.; Woodfin, G. (Univ. of Calif., Los Alamos National Lab., Los Alamos, NM 87545). pp 227-231 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The output beam from free-electron lasers tends to be a thin, pencil-like beam because of the nature of the gain volume. For moderate power devices, mirror damage considerations imply that the beam has to travel many meters before it can expand enough to allow retro-reflection from state-of-the-art mirrors. However, use of grazing incidence optics can resolve the problems of damage to the optical elements and result in a cavity of reasonable dimensions. The optical design considerations for such resonators are addressed in this paper. A few of the practical resonator designs approaching diffraction limited performance are presented.

38600 **Long-base free electron laser resonant cavity.** Miller, E.; Bender, S.; Appert, Q.; Saxman, A.; Swann, T. (Univ. of California, Los Alamos National Lab., Los Alamos, NM 87545). pp 235-239 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

A 65-meter resonant cavity has been constructed in order to experimentally determine the characteristics of long resonant cavities as would be required for a free electron laser (FEL). A version using normal incidence mirrors is reported here, and another that includes a grazing incidence mirror is forthcoming. Either version is designed to simulate a FEL operating at 0.5 micron wavelength and is near-concentric with a stability parameter of 0.98. Argon-ion plasma tubes simulate the laser gain that would be provided by a wiggler in an actual FEL. The cavity was constructed on a seismic slab and air turbulence effects were reduced by surrounding the beam with helium in 6″ diameter tubes. Alignment sensitivities are reported and compared to geometrical and diffraction predictions with good agreement.

38601 **Quasi-analytical description of sideband formation in a free-electron laser (FEL).** Elliott, C.J. (Applied Theoretical Div., Los Alamos National Lab., Los Alamos, NM 87545). pp 240-246 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

A simple method of looking at sideband development in a free-electron laser has been developed. It reduces a two-dimensional (z,t) mathematical formulation to a one-dimensional (t) formulation. A graphical interpretation gives the intensity increment on the leading edge of a square optical pulse in the two-dimensional problem in terms of the average energy loss curve for the electrons in a one-dimensional problem.

38602 Gallium arsenide photocathode for the free electron laser. Stotlar, S.C.; Springer, R.W.; Sherwood, B.; Cordi, R. (Los Alamos National Lab., Materials Science and Tech. Div., Los Alamos, NM 87545). pp 251-260 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The efforts of the FEL source have been concentrated on cesiated GaAs(100) wafers. These crystals have shown photoyield of <.1-9 percent quantum efficiency with the cesium and oxygen treatment. The work function and coverage curves exhibit the same properties as measured in the literature. The use of Auger Electron Spectroscopy and X-ray Photoelectron Spectroscopy have been instrumental in determining the surface cleanliness and the surface oxidation states. The sputtered surfaces have been investigated as a function of rate gas mass and sputter ion voltage, giving similar results to earlier literature values. Temperature annealing appears to be critical after sputter cleaning in achieving any significant photoyield. Contacts of Ag-Mn and Ni-Si have been deposited, heated, and analyzed using Auger Depth Profiling techniques.

38603 Spectral characterization of a tunable alexandrite laser by rubidium absorption at 780 nm. Nowak, A.V.; Krohn, B.J. (Chem. Div., Los Alamos National Lab., Los Alamos, NM 87545). pp 269-278 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

Rubidium vapor was used to characterize the output of a tunable, pulsed alexandrite laser operating at 780 nm. Rubidium spectra were obtained at temperatures of 23, 50, 110, and 140°C. Excellent agreement was obtained with computer-synthesized spectra in which laser linewidth $5^2P/sub\ 3/2/ < 5^2S/sub\ 1/2/$ transition was represented by a Voigt profile while a Guassian profile was assumed for the laser pulses. Optimum calculated values for the laser linewidth at a pumping energy 40% above threshold were 0.065 cm^{-1} and 0.035 cm^{-1} for the Q-switched pulse and for the free-running train of pulses, respectively. The laser output was found to be spectrally compact with no evidence of energy outside the narrow central feature.

38604 E-beam-induced fluorescence of excimers in cryogenic solutions. Loree, T.R.; Showalter, R.R.; Johnson, T.M.; Telle, J.M.; Fisher, R.A.; Hughes, W.M. (Los Alamos National Lab., Chem. Div., Los Alamos, NM 87545). pp 279-283 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The authors have detected the fluorescence emitted from excimer molecules formed in e-beam-pumped mixtures in a liquid argon host. The mixtures were both binary (halogen donors in the liquid argon) and ternary (dilute concentrations of donors and other rare gases in the liquid argon). Many excimers were observed, including the rare-gas dimers Xe_2, Kr_2, and Ar_2. Strong fluorescence was seen from XeF, XeCl, and ArO.

38605 Diode-laser-pumped Nd:YAG laser injection seeding system. Schmitt, R.L.; Rahn, L.A. (Sandia National Labs., Combustion Research Facility, Livermore, CA). pp 64 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The advantages of single axial mode Q-switched Nd:YAG lasers for nonlinear optics and high-resolution spectroscopy are well recognized. In particular, it is becoming clear that such sources may be required for quantitative applications of nonlinear spectroscopies such as coherent anti-Stokes Raman spectroscopy (CARS). The injection seeding technique, described in some detail by Park et al., has been used to produce single-mode Q-switched operation of a Nd:YAG laser. This paper describes successful injection seeding of a commercial Nd:YAG laser using a diode-laser-pumped Nd:YAG laser and a permanent magnet Faraday isolator. The advantages of this system are its small size, simplicity, and high reliability.

38606 Strengthening of solid-state laser materials. (Lawrence Livermore National Lab., Advanced Solid State Laser Program, P.O. Box 5508, Livermore, CA). pp 232 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Marion, J.E. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

Active components in solid-state lasers require materials that are resistant to fracture from thermal loading. Design data suggest that component failure from thermal stresses may be a primary limitation on power output in high-average-power applications. The strength of brittle crystalline and glass laser materials in the presence of thermally induced surface tensile stresses depends both on the material's inherent resistance to crack extension under load (the fracture toughness) as well as the size of the flaws that inevitably exist at the surfaces. It is found that conventional fabrication techniques involving mechanical polishing give optical quality surface finishes that contain a layer of surface damage that may extend several hundred microns into the material. The damage is introduced during grinding and is not removed during subsequent polishing. Components fracture at moderate stress levels due to these large cracks despite good optical appearance.

38607 Spectroscopic and thermomechanical properties of new neodymium-doped laser materials. Stokowski, S.E.; Marion, J.E. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 232 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

New solid-state laser media will improve the efficiency, average power, and beam quality of laser systems. Recently gadolinium scandium gallium garnet (GSGG) crystals have produced the highest efficiency laser operation reported for a rod laser. For high-average-power systems enploying the zigzag configuration or the gas-cooled disk configuration, GSGG will be useful for small-aperture systems. In large-aperture systems, new silico-phosphate glasses developed by Hoya Optics and by Schott Glass Technologies have advantages over the presently used LHG-5 phosphate glass. Future lasers for fusion research, which will have megajoule pulse energies, will require an inexpensive phosphate glass with improved thermomechanical characteristics. In the long run laser drivers for inertial confinement fusion reactors will need an efficient low-nonlinear-index crystalline laser medium; fluoride crystals are prime candidates. To evaluate the suitability of materials for these laser applications, the authors are measuring the spectroscopic properties of many new laser glasses and the thermomechanical characteristics of glasses and crystals. They have compiled the property values from the published literature, measurements done by Schott and Hoya, plus their own measurements.

38608 Measurements of losses and lasing efficiency in Nd:Cr:GSGG laser rods. Caird, J.A.; Krupke, W.F.; Shinn, M.D.; Smith, L.K.; Wilder, R.E. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 232 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

Gadolinium scandium gallium garnet crystals co-doped with neodymium and chromium ions (Nd:Cr:GSGG) have been shown to yield significantly higher lasing efficiency than Nd:YAG when pumped by flashlamps. The improvement results from increased efficiency of absorption of flashlamp light by Cr^{3+} ions followed by rapid energy transfer to the emitting Nd^{3+} ions. A number of co-

doped GSGG laser rods obtained from four different vendors have been tested in this laboratory. The lasing threshold and efficiency were found to vary substantially from rod to rod. Some of these variations can be attributed to differences in dopant densities, but much larger effects were caused by differences in absorption, distortion, and scattering losses. Measurements of the absorption spectra of the laser crystals in several cases revealed the presence of an anomalous absorption band stretching from 800 to 1200 nm. The absorption coefficient of this band at the 1061-nm laser wavelength has been observed to vary over 3 orders of magnitude from a high of 2 cm^{-1} down to 1 x 10^{-3} cm^{-1}. Some crystals had no measureable broad absorption in this wavelength range (1 x 10^{-4}-cm^{-1} detection sensitivity).

30609 Optical performance of the Los Alamos free-electron laser. Newnam, B.E.; Warren, R.W.; Sheffield, R.L.; Lynch, M.T.; Stein, W.E.; Fraser, J.S.; Winston, J.G.; Goldstein, J.C.; Watson, J.M.; Brau, C.A. (Los Alamos National Lab., P.O. Box 1663, Los Alamos, NM). pp 262 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

During the past year of oscillator experiments, the Los Alamos free-electron laser (FEL) has demonstrated high-power and diffraction-limited output capabilities with a factor-of-4 wavelength tunability in the IR. The conversion of electron energy into optical radiation occurs within a 1-m long undulator composed of $SmCo_5$ permanent magnets arranged in a uniform-period plane-polarized configuration. Relativistic electron pulses are supplied by a conventional RF linear accelerator operating at 1.3 GHz with a nominal energy of 20 MeV. Sufficient RF power is supplied to the accelerator to produce a burst of 2000 uniform-current micropulses, each $\approx$40 psec in width and spaced by 46 nsec, the round-trip time of light in the 6.9-m optical cavity. Peak currents in excess of 50 A have been directed through the undulator. The primary experiments, however, were conducted with a peak current of $\approx$30 A, a longitudinal energy spread of 2%, and a transverse emittance of 3π mm] mrad.

30610 Ultrasensitive gain measurements in I2 and IF. Williamson, R.L.; Hanko, L.; Davis, S. (Sandia National Laboratories, Albuquerque, NM). pp 278 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The authors report results of efforts to develop a highly sensitive quantitative small-signal gain (SSG) measurement technique for use in evaluation of potential chemically pumped visible laser systems. Intracavity gain loss techniques using cw dye lasers as a gain probe are known to have high sensitivity. The method typically involved placing the gain medium into the cavity of a cw dye laser. The gain existing in the dye is then utilized to offset all losses in the cavity. Thus any gain existing in the test medium enhances the dye laser output since all losses are automatically overcome by the dye. Net gains as small as 10^{-4} or 0.01% are detectable using this technique.

30611 Optical properties of $Cr^{3}V$ and Nd^{3}+ions in GGG(Ca,Zr) and GGG(Ca,Mg,Zr). Shinn, M.D.; Krupke, W.F.; Caird, J.A.; Smith, L.K. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 234 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The discovery of Cr^{3+} - and Nd^{3+} -doped oxide garnets such as gadolinium scandium gallium garnet (GSGG) having efficiencies greater than Nd:YAG has led to their proposed use in high-average-power laser systems. The high-stimulated-emission cross section for Nd^{3+} in this material limits the size of the active medium, which will impose limititations on the maximum power output per laser active component. If the Nd^{3+} cross section in this material could be reduced, while keeping other parameters constant, the components could be scaled to larger apertures. Materials which may satisfy these requirements are gadolinium gallium garnet (GGG), whose structure is modified by calcium and zirconium GGG(Ca,Zr) or calcium, magnesium, and zirconcium GGG(Ca,Mg,Zr). These crystals were originally synthesized for use as magnetic bubble memory substrates. When doped with Nd^{3+}, the large degree of inhomogeneous broadening evident in the emission spectrum indicates that many nonequivalent Nd^{3+} sites exist. These nonequivalent sites are due to the many different positions the charge-compensated ion pairs (Ca-Zr) or (Mg-Zr) may assume in the lattice. This inhomogeneous broadening lowers the stimulated emission cross section, yet leaves most other optical properties relatively unchanged compared with GGG. These materials can also be doped with Cr^{3+} to sensitize efficiently the Nd^{3+} luminescence, as is done in GSGG. Laser performance of the Cr:Nd:GGG(Ca,Zr) material exceeds that for Nd:YAG. Further improvements in performance can be expected when better optical quality in the materials is achieved.

30612 Recycling of optical radiation by flash-lamps. Powell, H.T.; Jancaitis, K.S.; Trenholme, J.B.; Uhrich, C.E.; Wirtenson, G.R. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 252 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

It is well known that flashlamps behave as gray bodies which can absorb as well as emit radiation. Their conversion efficiency of absorbed radiation to emitted power is of considerable importance in understanding solid-state lasers and improving their efficiency. The authors have studied this problem experimentally and modeled our results computationally. The experimental approach relies on comparing the output power as a function of wavelength for a flashlamp coated with a dielectric reflector to one with no coating. They have observed clear enhancement of the lamp output produced by such optical feedback and have made estimates for the reemission efficiency of the absorbed radiative power. The flashlamps under study have a bore diameter of 1.9 cm and an arc length of 47 cm and are filled with 300 Torr of Xe. They were excited by an LC circuit where the input energy ranged from 0.05 to 0.28 of the explosion energy. The lamp size and electrical parameters were chosen to be representative of those used in flashlamp excitation of large Nd:glass disk amplifiers.

30613 Gain, lasing, and tuning characteristics of $Ti:Al_2O_3$. Barnes, N.P.; Remelius, D.K. (Los Alamos National Lab., P.O. Box 1663, Los Alamos, NM). pp 168 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The gain of a laser-pumped laser was calculated and compared with experimental results. Usually the most difficult quantity to calculate for a solid-state laser is the population inversion. However, by using longitudinal laser pumping, not only the population inversion but the population inversion density can be determined. From this, the gain for a Gaussian beam was calculated as a function of the ratio of the laser beam radius to the pump beam radius. The calculation can be performed exactly for two situations where the ratio of the beam radii approaches zero and where the ratio of the beam radii equals unity. Results of these calculations are compared to experimental observations. The lasing characteristics of the $Ti:Al_2O_3$ laser were determined experimentally and compared to modeling projections. With a knowledge of the gain of the laser, the laser performance can be predicted. The predicted performance characteristics include energy output as a function of pump energy, pulse length as a function of energy output, slope efficiency, and threshold as a function of mirror reflectivity. The dependences were then measured experimentally and compared to the prediction. In all cases, reasonable agreement between the predicted and measured values were found.

38614 Elevated temperature extraction measurements of a high Kr-concentration KrF laser. Kimura, W.D.; Salesky, E.T. (Spectra Technology, Inc., 2755 Northup Way, Bellevue, WA). pp 170 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

Recently, the authors performed room-temperature extraction measurement of e-beam-pumped KrF laser mixtures (Ar diluent) containing 4-99.6% Kr. The results demonstrate that Kr-rich mixtures have comparable efficiencies to conventional 4-6% Kr mixtures at high pressures (≧ 1.7 atm). Improving the performance of the Kr-rich mixtures may be possible by increasing the initial temperature of the medium to reduce Kr_2F] formation as originally suggested by Shui. The formation of Kr_2F reduces gain by quenching KrF] and by absorbing at the laser wavelength. Measurements by Klimek and Hsia[4] confirm that this reaction has a temperature dependence. The temperature dependence of the 10% Kr mixture is expected to be weak, since the effect of the Kr_2F] loss is much less significant for this mixture. Extraction measurements are obtained for two different gas mixtures (89.7% Ar/10% Kr/0.27% F_2 at 1.23 amagats and 99.6% Kr/0.4% F_2 at 0.81 amagates) at various initial gas temperatures (294-425 K). These are two of the mixtures studied at 294 K. The 10% Kr demonstrated the best performance with an average efficiency of 11.7% and a peak power efficiency of 13.1%. This mixture is being used as a reference to evaluate the performance of the 99.6% Kr case.

38615 TE/sub II/ and TE_{01} mode competition in unmagnetized free electron lasers. Lin, A.T.; Lin, C. (Dept. of Physics, Univ. of California, Los Angeles, CA). pp 4B-5 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—).

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

A newly developed waveguide particle code which is capable of including all TE/sub NM/ modes is used to simulate unmagnetized free electron laser experiments. The model allows three dimensional spatial motion for electrons as well as transverse inhomogeneity of magnetic wiggler. The parameters used in simulations are relevant to the most recent experiment carried out at Naval Research Laboratory. Initially, the electrons possess only longitudinal momentum and the wiggler field strength is set to zero. The wiggler field strength is turned on slowly to its full strength in a few wiggler periods and the electrons will find their own equilibrium. The effects of the mode competition on the nonlinear efficiency and the transverse inhomogeneity of the wiggler on the electron dynamic are addressed.

38616 Experimental study of millimeter wave generation from rotating electron beams in a rippled magnetic field. Destler, W.W. (Univ. of Maryland, College Park, MD). pp 1B-5 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—).

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The production of millimeter and submillimeter wave radiation from rotating electron beams in azimuthally periodic wiggler fields is being investigated experimentally and theoretically. This work is a collaborative effort between researchers at the University of Maryland and the Massachusetts Institute of Technology. In experiments to date, a 2 MeV, 1-2 kA, 5 ns rotating electron beam is produced by passing a nonrotating hollow beam through a narrow magnetic cusp. The beam electrons downstream of the cusp transition perform cyclotron orbits in a uniform axial magnetic field of about 1400 Gauss. An azimuthally periodic wiggler field essentially transverse to the electron motion is produced by samarium cobalt magnets located behind coaxial conducting boundaries interior and exterior to the beam. Such a circular geometry Free Electron Laser (FEL) may offer advantages over linear systems, including a more compact configuration, a longer effective wiggler region, and internal feedback resulting from the recirculation of the scattered electromagnetic wave. Theory and experiment both show that the wiggler field does not have a disruptive effect on the electron orbits, and that the perturbation in the electron trajectories is primarily in the axial direction, as desired.

38617 Design of e-gun for large KrF amplifiers. Reilly, D.A.; Von Rosenberg, C.W. (Avco Everett Research Lab., Inc., Revere Beach Pkwy., Everett, MA). pp 172 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850588—).

From Global potentialities of gas fuels and feedstocks; Los Angeles, CA, USA (31 May 1985).

The design of very large single-aperture laser amplifier for an angular multiplexed laser fusion system requires advances in excimer laser e-gun technology beyond existing designs. Scaling considerations dictate the use of multiple e-guns to pump a single laser; in the present case the authors will discuss the scaling and design features of one of the ten e-guns being developed to pump the Los Alamos Polaris Power Amplifier Module. Multiple e-guns minimize the diode self-magnetic field, lowering the size of the imposed guide magnetic field, and reducing the diode impendance collapse. Multiple guns also result in lowered current rise times, reduce the development cost of the technology at the prototype stage, and, of course, limit the cost due to operation failures in the e-gun. The present design utilizes the expanding electron flow diode to provide uniform electron flow into the gas from a high-current density cold cathode ($\approx$50 A/cm^3). Laminated iron and an imposed dipole field are utilized for B-field shaping. The applied B field lines trace from the anode, terminate on the cathode, and are then conducted through the shank to beyond the bushing. This feature not only provides for fully expanded electron flow from cathode to anode, but it also allows for self-magnetic field insulation of the shank and bushing, thus minimizing voltage standoff distances, inductance, and rise time. A single large aspect ratio racetrack-shaped bushing on each e-gun is provided with robust grading to limit field concentration at the ends.

38618 Fluoride pulses. Thomas, S.J.; Burrows, M.D. (Los Alamos National Lab., P.O. Box 1663, Los Alamos, NM). pp 172 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

A front-end laser system for the KrF inertial confinement fusion laser is being assembled at Los Alamos. This laser system provides the initial 5-nsec KrF pulse, which is temporally and spatially multiplexed into 96 beams of 5-nsec duration to drive efficiently long-pulse (500-nsec) electron-beam-pumped amplifiers. Using a Pockels cell and crossed polarizers, a 5-nsec pulse is sliced from the 25-nsec pulse from a discharge-pumped injection-locked KrF laser which provides a high-quality KrF beam. Neglecting polarizer and Pockels cell optical transmissions, the 5-nsec pulse is extracted from this longer pulse with a duty cycle of 20% and a 5-nsec switching efficiency of 25% for a net efficiency of 5%. The 5-nsec pulse energies from a single Pockels cell switch are typically 7.5 mJ which is sufficient to extract 200 mJ from a single pass through a discharge-pumped postamplifier with a 93-X 9-cm^3 gain volume. The 5-nsec input pulse is smoothly varying in time with rise and fall times of 1.5 nsec and a nearly flat plateau of 2-nsec duration at the pulse center. Although the pulse width is not significantly altered by amplification, the input pulse shape is not reproduced following amplification. The amplified pulse displays a sharp 2-nsec spike at the leading edge that is twice as intense as the remainder of the pulse. This pulse shape alteration reflects an effective gain recovery time of more than 5 nsec in display-pumped KrF amplifiers.

38619 Blackbody pumping of neodymium laser glass. Jancaitis, K.S.; Masquelier, D.A.; Powell, H.T. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 252 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The authors investigated both the theoretical limits and the experimental realities of blackbody pumping of Nd:glass. The calculational model is particularly relevent for Nd pumping by chemical (pyrotechnic) lamps. It is also pertinent as a limit on the pumping rate in laser amplifier using conventional electric flashlamps which behave as gray bodies. Experimentally, they have examined the temporal, spatial, and spectral character of the radiative output from 120-cm long, 1.2-cm i.d. chemical flashlamps which burn zirconium in both oxygen and oxygen difluoride. They made direct comparison of the Nd* excitation levels produced by the pyrotechnic lamps to a xenon flashlamp of similar size and energy loading (electrical instead of chemical). Moreover, because they previously made quantitative calorimetric measurements of the Xe flashlamp output, they obtained absolute output powers and energies of the pyrotechnic lamps by comparison to the Xe standard.

4204 Heat Transfer And Fluid Flow

REFER ALSO TO CITATION(S) 37832, 37833, 37834, 37835, 38185, 38250, 38454, 38569, 38571, 39425

38620 (CONF-860805—3) Flow-induced vibration in shell-and-tube heat exchangers with double-segmental baffles. Halle, H.; Chenoweth, J.M.; Wambsganss, M.W. (Argonne National Lab., IL (USA); Heat Transfer Research, Inc., Alhambra, CA (USA)). 1986. Contract W-31-109-ENG-38. 16p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86003064.

From International heat transfer conference; San Francisco, CA, USA (17 Aug 1986).

One of the techniques used by designers of shell-and-tube heat exchangers when they encounter a potential flow-induced vibration problem is to shift from a tube bundle with segmental baffles to one with double-segmental baffles. This results in a split of the flow into either half of the shell with lower velocities and the possibility to reduce the unsupported tube span length while keeping below a given allowable pressure drop. Tests performed as a part of a systematic study of water flow-induced vibration in industrial-sized heat exchangers have demonstrated the possibility of exciting vibration in tubes exposed to localized high velocities as a consequence of inherent flow maldistributions in the end zone regions. Results for nine different double-segmental bundle configurations are presented. Comparison with similar results for segmental baffled bundles, where available, indicates that vibration is normally observed at somewhat higher total flows for double-segmental baffled bundles.

38621 (CONF-860805—8) Spirally fluted tube heat exchanger as a condenser and evaporator. Panchal, C.B.; Buyco, E.H.; Yampolsky, J.; Bell, K.J. (Argonne National Lab., IL (USA); Purdue Univ., Hammond, IN (USA); GA Technologies, Inc., San Diego, CA (USA); Oklahoma State Univ., Stillwater (USA)). 1986. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007514.

From International heat transfer conference; San Francisco, CA, USA (17 Aug 1986).

A new type of spirally fluted tube has been tested in a shell-and-tube heat exchanger in both condensing and evaporating service and has shown substantial improvement in performance over that expected from a comparable exchanger with plain tubes. The condensation tests were run with ammonia and R-114 condensing on the shell side with cooling water in the tubes. The evaporation tests were run with R-114 and R-11 boiling on the tube side in upward forced convection and steam condensing on the shell side as the heating medium. The spirally fluted tube heat exchanger was tested for industrial cogeneration applications, including organic Rankine cycles. However, it has potential applications for ocean energy, heat pump systems, and process industries.

38622 (CONF-860805—9) Free convection heat transfer in the critical region of binary fluid mixtures. Jump, D.; Marschall, E. (California Univ., Santa Barbara (USA). Dept. of Mechanical and Environmental Engineering). 1986. Contract AS03-84ER13164. 7p. (CONF-8510176—4). NTIS, PC A02/MF A01; GPO Dep. File Number DE86008856.

From International heat transfer conference; San Francisco, CA, USA (17 Aug 1986).

Free convection heat transfer from a heated wire to near critical binary mixtures of R-22 and R-115 was investigated experimentally. Measurements included determination of mixture bulk temperature and pressure, wire temperature and heat flux at the wire surface, and mixture concentration. Observed heat transfer and fluid flow patterns were very similar to those known to occur in near critical pure fluids. Modest peaks in heat transfer coefficients were found at small temperature differences for all mixtures. For bulk fluid temperatures slightly below their critical temperatures boiling-like phenomena were observed and the corresponding maximum heat transfer coefficients were found to be up to 600% higher than those obtained at larger temperature differences. 11 refs., 11 figs.

38623 (SAND—85-1552C) Application of flux-corrected transport (FCT) to high Rayleigh number natural convection in a porous medium. Gross, R.J.; Baer, M.R.; Hickox, C.E. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 29p. (CONF-860805—4). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86004603.

From International heat transfer conference; San Francisco, CA, USA (17 Aug 1986).

A numerical technique designed to solve a wide class of convectively dominated flow problems is applied to natural convective flow in a porous medium at large Rayleigh number. The technique is a finite difference method based on flux-corrected transport (FCT) and possesses four desirable numerical properties: stability, accuracy, monotonicity, and conservation. Steady natural convection is investigated for Rayleigh numbers as large as 10,000. An efficient methodology for obtaining steady state solutions is illustrated. A simulation is performed for transient thermal convection at a Rayleigh number of 2500. Transient natural convection involving both heat and mass transfer is illustrated for a Rayleigh number of 2500, Lewis number of 2, and buoyancy ratio of 0.1. All simulations are performed in a square cavity with heated vertical side walls. 17 refs.

38624 (SAND—86-0021C) Evaluation of convective film boiling models with nonequilibrium data in tubes. Webb, S.W.; Chen, J.C. (Sandia National Labs., Albuquerque, NM (USA); Lehigh Univ., Bethlehem, PA (USA). Inst. of Thermo-Fluid Engineering and Science). 1986. Contract AC04-76DP00789. 25p. (CONF-860805—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86006471.

From International heat transfer conference; San Francisco, CA, USA (17 Aug 1986).

In convective film boiling, a high degree of thermodynamic nonequilibrium often occurs between the liquid and vapor phases. By measurement of the vapor superheat at varying distances downstream of the quench front, the axial variation of the vapor generation rate was determined. Contrary to commonly held expectations, the vapor generation rate is high near the quench front in a region of low vapor superheat, and low further downstream of the quench front where the vapor superheat is significantly higher. Comparison of predictions of existing nonequilibrium film boiling models with the data shows that these models are not able to predict the axial variation of the vapor superheat measured in the tests. However, most of the models are able to predict the heat flux data reasonably well. Comparison of a newly developed two-region film boiling model with the data shows substantially better agreement than existing models.

38625 **(SAND—86-0158C) Inviscid/boundary layer prediction of aerodynamics for a bent-axis biconic geometry.** Polansky, G.F.; Noack, R.W. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 11p. (CONF-860882—1). NTIS, PC A02. File Number DE86011185.

From Atmospheric flight mechanics conference; Williamsburg, VA, USA (18 Aug 1986).

Newly developed inviscid and boundary layer codes are applied to the prediction of forces and moments for both on-axis and bent-axis biconic orbital transfer vehicle configurations. The inviscid code solves the full three-dimensional form of the nonconservative Euler equations. It features parabolic grid generation and an improved method of characteristics boundary condition. The boundary layer code solves the integral forms of the momentum and energy equation along inviscid streamlines. Generally good agreement is found in comparisons of the inviscid/boundary layer predictions with the experimental data at angles of attack up to 30°.

38626 **(SAND—86-1412C) Buoyancy induced convection in a non-uniformly heated array of cubical elements on a vertical channel wall.** Ortega, A.; Moffat, R.J. (Stanford Univ., CA (USA). Dept. of Mechanical Engineering). 1986. Contract AC04-76DP00789. 12p. (CONF-860612—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012169.

From 4. AIAA/ASME thermophysics and heat transfer conference; Boston, MA, USA (2 Jun 1986).

Experiments have been performed to investigate naturally-induced convective heat transfer from an array of cubical elements that are deployed in an in line array on one wall of a vertical, open-ended parallel-planes channel. The application is in passive cooling of high density electronics, in which components, located in arrays of vertically arranged printed circuit board, are part of an asymmetrically heated channel, with one wall having large hydrodynamic roughness. An examination of the convective heat transfer from a single element in the family using purely local descriptors shows that the heat transfer is driven primarily by globally induced channel flow, rather than by local buoyancy mechanisms, when the channel walls are closely spaced and there is good fluid mixing at any streamwise location. It is preferable to describe the situation as one of "buoyancy induced forced convection." As long as the local ratio Gr/Re^2 is less than about 0.3, for the cube array, local buoyancy effects can be neglected, and the hydrodynamics are indistinguishable from pressure-driven forced convection. This is confirmed by a comparison of local heat transfer coefficient measured in both buoyancy induced and forced channel flows. A method is derived by which the channel Reynolds number may be predicted even for cases of streamwise non-uniform heat dissipation in the array using experimental measurements of array drag coefficients. With this flow prediction capability, and with a data base that includes adiabatic heat transfer coefficients, and thermal wake decay functions, it is possible to implement an analytically exact linear superposition method to predict array element temperatures in a non-uniformly heated array.

38627 **(UCRL—94273) Shower and high-pressure oil temperature control.** DeBra, D.B.; Victor, R.A.; Bryan, J.B. (Stanford Univ., CA (USA). Dept. of Aeronautics and Astronautics; Lawrence Livermore National Lab., CA (USA)). Mar 1986. Contract W-7405-ENG-48. 20p. (CONF-860839—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009398.

From 36. International Institution for Production Engineering Research general assembly; Jerusalem-Haifa, Israel (16 Aug 1986).

Oil showering for temperature control of precision tools is an effective way of achieving close temperature stability and isolation from variations in room air temperature. The oil must be controlled to temperature variations less than tolerances specified for machine and parts. Principal disturbances come from heat transfer into the plumbing between the heat exchanger and the tool and from variations in the chill water in the heat exchanger. We describe the successful employment of measuring techniques, isolation from disturbances, and the use of integral control with proportional and commercially available temperature controllers. Commercially available heat exchangers are low-pressure devices. For high-pressure oil applications a pump follows the heat exchanger, and, because of the high velocities and large surface area, the oil passing the pump is sensitive to heat from its motor and from room air. Combinations of feedback from different locations in the system are discussed. Compromises with regard to measuring at the functional point versus minimizing time delay, and the importance of measuring near the site of disturbing heat sources lead to multiple sensors in some cases. Each measurement may be used through integral feedback to provide the best performance. The introduction of integral control to commercial a-c bridge controllers can be awkward. Six approaches are compared, and the millidegree performance of our current designs is presented.

38628 **(Y/DW—627) Heat measurements in inertia welding of aluminum to steel.** Reagan, R.J. (Oak Ridge Y-12 Plant, TN (USA)). Jun 1986. Contract AC05-84OR21400. 21p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012463.

Measurements of the total heat generated at the interface during inertia welding of 316 stainless steel to aluminum-1100 (99.5% pure) at the Oak Ridge Y-12 Plant are presented. Transient temperature measurements of the weld are also given. A full treatment of calorimetric methods is included in the discussion. In measuring the heat generated during the weld, it was found that the conversion efficiency of kinetic energy in the flywheel to frictional heat energy at the interface is greater than 85%.

38629 **Prandtl Number Effect on Benard Convection in Porous Medis.** Georgiadis, J.G.; Catton, I. (Mechanical, Aerospace and Nuclear Engineering Department, University of California, Los Angeles, CA 90024). *Journal of Heat Transfer;* **108**: No. 2, 284-290(May 1986). Contract AS03-82ER12021.

A numerical study of buoyance-driven two-dimensional convection in a fluid-saturated horizontal porous layer is reported emphasizing the nonlinear inerital effect on heat transport. The Forchheimer-Brinkman-Darcy-Boussinesq formulation and a single energy equation for the volume-average temperature are used. Closure to the wavenumber selection problem is sought through a criterion based on the Glansdorff and Prigogine theory of nonequilibrium thermodynamics. Good agreement with laboratory data and the analogy with th Rayleigh-Benard problem are corroborative facts which justify smililar non-Darcian formulations and demonstrate the role of the quadratic inertial terms in decreasing the mean convective heat transfer across the layer.

38630 **Effects of ambient pressure on the instability of a liquid boilng explosively at the superheat limit.** Frost, D.; Sturtevant, B. (Graduate Aeronautical Laboratories, California Institute of Technology, Passadena, CA 91125). *Journal of Heat Transfer;* **108**: No. 2, 418-424(May 1986). Contract AS03-80ER10634.

The effect of ambient pressure on the intrinsic instability of rapid vaporization in single droplets boiling exposively at the limit of superhead has been studied experimentally and theoretically. The instability that distortsthe evaporating interface and substantially enhances the mass flux at atmospheric pressure is suppressed at high pressure. The radiated pressure field is two orders of magnitude smaller from stabilized bubbles than from unstable. At intermediate pressures bubble growth occurs in two stages, first stabe, then unstable. The Landau-Daarrieus instability theory predicts absolute stability at atmospheric pressure for a spherical bubble whereas the theory for planar interfaces yields results in general agreement with observation. The sensitiviy of the instability to temperature suggests that small temperature nonuniformites may be responsible for quantitative departures of the behavior from predictions.

38631 **Review and analysis of boundary layer transition data for turbine application.** Gaugler, R.E. (NASA, Lewis Research Center, Cleveland, OH). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

A symposium on transition in turbines was held at the NASA Lewis Research Center. One recommendation of the working groups was the collection of existing transition data to provide

standard cases against which models could be tested. A number of data sets from the open literature that include heat transfer data in apparently transitional boundary layers, with particular application to the turbine environment, were reviewed and analyzed to extract transition information from the heat transfer data. The data sets reviewed cover a wide range of flow conditions, from low speed, flat plate tests to full scale turbine airfoils operating at simulated turbine engine conditions. The results indicate that free stream turbulence and pressure gradient have strong, and opposite, effects on the location of the start of transition and on the length of the transition zone. 13 references.

39632 **Heat transfer measurements with film cooling on a turbine blade profile in cascade.** Horton, F.G.; Schultz, D.L.; Forest, A.E. (Oxford Univ., England; Rolls-Royce, Ltd., Derby, England). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

Heat transfer measurements with film cooling have been made on a gas turbine rotor profile in a cascade at engine representative operating conditions. The blade temperature was varied independently to investigate the scaling of heat transfer coefficient, and a superposition model was found to correlate the data. Contrasting results are presented for films on the two surfaces, along with predictions from a two-dimensional boundary layer method. 18 references.

39633 **Thermodynamics of gas-turbine cycles. II. A model for expansion in cooled turbines.** El-Masri, M.A. (MIT, Cambridge, MA). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

The efficiency and the specific output of gas-turbine cycles can be improved by raising turbine inlet temperatures. However, the surfaces of the components exposed to the hot gas must be maintained at temperatures which do not exceed a certain upper limit. The thermodynamic penalties of the required cooling process can compensate partly for the advantages obtained as a result of the increased inlet temperature, and, eventually, when a certain inlet temperature is exceeded, the cycle thermal efficiency will actually decrease. A number of models have been considered for evaluating the thermodynamic penalties associated with cooling. The present paper has the objective to provide a model which has been sufficiently simplified to make the derivation of closed-form solutions possible, while adequate detail is retained for the computation of useful numerical results. The model is applied to three cooling systems, related to internal air cooling, transpiration air cooling, and internal liquid cooling. 17 references.

39634 **Development of an impact capability for the three-dimensional fluid-structure interaction code - NEPTUNE.** Kulak, R.F.; Fiala, C. (Argonne National Lab., IL, USA. Reactor Analysis and Safety Div.). pp 143-154 of Transactions of the 8. international conference on structural mechanics in reactor technology. Vol. B. Computer methods for structural analysis. Stalpaert, J. (ed.). Amsterdam, Netherlands; North-Holland (1985). (CONF-850809—; EUR—10001-DE/EN/FR).

From 8. international conference on structural mechanics in reactor technology; Brussels, Belgium (19 Aug 1985).

A method, which uses a family of adaptive contact elements, is developed for treating the mechanics of contact/impact between two deformable bodies. The contact element's nodal connectivity is allowed to change during the computations in order to accommodate finite sliding. The methodology has been implemented into the NEPTUNE finite element program. Results are presented for an illustrative problem.

39635 **Active ultrasonic cross-correlation flowmeters for mixed-phase pipe flows.** Sheen, S.H.; Raptis, A.C. (Argonne National Lab., IL). *ISA (Instrument Society of America) Transactions;* 24: No. 2, 53-58(1985).

From 30. international instrumentation symposium; Denver, CO, USA (1984).

This paper describes two ultrasonic flowmeters that employ the active cross-correlation technique and use a simple clamp-on transducer arrangement. The flowmeter for solid/liquid flows was tested over a wide range of coal concentrations in water and oil. The measured velocity based on the peak position of the cross-correlation function is consistently higher by about 15% than the average velocity measured by flow diversion. The origin of the difference results mainly from the flow velocity profiles and transit time probability distribution. The flowmeter that can measure particle velocity in a solid/gas flow requires an acoustic decoupling arrangement between two sensing stations. The measured velocity is mainly associated with the particles near the wall. Performance is described for both flowmeters. 13 references, 9 figures, 2 tables.

39636 **Fully developed combined heat and mass transfer natural convection between parallel plates with asymmetric boundary conditions.** Nelson, D.J.; Wood, B.D. New York, NY; American Society of Mechanical Engineers (1985). 6p. (CONF-851125—).

From American Society of Mechanical Engineers winter annual meeting; Miami, FL, USA (17 Nov 1985).

An analysis of fully developed flow between parallel plates is presented for combined heat and mass transfer natural convection with asymmetric boundary conditions. Closed form solutions are obtained for uniform wall temperature and concentraction (UWT/C) and uniform heat and mass fluxes (UH/MF). For UWT/C, the solution is independent of Prandtl, Schmidt and Grashof numbers. For UH/MF, an analytical solution can be obtained only for equal Prandtl and Schmidt numbers. By assuming a purely parabolic velocity profile, an approximate solution for general Prandtl and Schmidt number is obtained that reduces to the analytical solution as a special case. The channel flow rate decreases in proportion to the square root of the Grashof number and depends on the Prandtl and Schmidt numbers as well as the boundary conditions. The highest Nusselt and Sherwood numbers occur for asymmetric boundary conditions, opposite of the results for forced convection duct flows.

39637 **Experiment on laminar flow in a rotating, curved duct of rectangular cross section.** Hoover, M.D.; Stoeber, W.; Morawietz, G. (Inhalation Toxicology Research Institute, Albuquerque, NM). *Journal of Fluids Engineering;* 106: 38-44(Mar 1984). Contract AC04-76EV01013.

Experimental results are presented here for laminar flow in a rotating, curved duct of rectangular cross section. The duct geometry is that of the spiral duct aerosol centrifuge designed by Stoeber and Flachsbart (1969). Primary velocity was measured by laser Doppler anemometry. Secondary flow velocity was characterized by dye injection. The experiment was done in a dynamically similar Plexiglas mockup of the centrifuge. Water flow in the mock-up simulated air flow in the aerosol centrifuge. The Reynolds number based on hydraulic diameter was 500. The Rossby number was 0.16. The duct aspect ratio was 3.3. Results are compared for flow in a straight stationary duct, the curved duct with no rotation, the curved duct with rotation in the direction of flow and the curved duct with rotation in the direction opposite of flow. There is agreement between the observed flow and the boundary layer theory of Ludwieg (1951). 18 references, 6 figures, 1 table.

39638 **Dislocation kinetics and acoustic wave approximation for liquids.** Stout, R.B. (Lawrence Livermore National Lab., CA). *International Journal of Engineering Science;* 22: No. 8-10, 1159-1166(1984). Contract W-7405-ENG-48.

A dislocation dependent model for liquids describes the lattice deformation and the fluidity deformation as additive deformations. The lattice deformation represents distortions of an atom's potential energy structure and is a recoverable deformation response. The fluidity deformation represents discontinuous repositioning of atoms by dislocation kinetics in the lattice structure and is a nonrecoverable deformation response. From this model, one concludes that in liquids the acoustic wave approximation is a description of a recoverable oscillation deformation that has dissipation because of dislocation kinetics. Other more complex waves would rapidly disappear because of the small thermodynamic potential for dislocation kinetics in liquids. 18 references.

38639 Bubble cavitation and dissolution. Cha, Y.S. (Argonne National Lab., IL). *International Journal of Heat and Mass Transfer;* **26**: No. 8, 1173-1180(1983).

The equilibrium equations of a bubble-droplet system are derived under more general conditions than previously reported. The stability of such a bubble-droplet system is examined via a diffusion argument. It is shown that the bubble-droplet system possesses not only a dissolution limit, known previously, but also a cavitation limit. Results of diffusion consideration supports that of thermodynamic analysis which demonstrated that both limits exist for a system without a droplet. Thus, the results of this paper further confirms the earlier conclusion that a bubble can remain in a state of stable equilibrium in a finite system under certain circumstances. Applications of the results require that a system boundary be identified such that little or no net mass transfer occurs across the boundary. 8 references, 5 figures.

38640 Transfer rate calculations for compositionally dissimilar interacting particles. Labowsky, M. (Yale Univ., New Haven, CT). *Chemical Engineering Science;* **35**: 1041-1048(1980). Contract FG01-78ET11384.

The method of images is shown to be applicable to the problem of calculating the transfer rates of interacting spherical particles, which differ in size and chemical composition. The method can be applied to any transfer problem in which the governing transport equations can be reduced to the Laplace equation and the particles have iso-potential surfaces. From a sample calculation it is found that, while particle interactions do not affect particle temperatures, they may severely affect the particle transfer rates. The effect of interactions on these transfer rates may be either positive (enhance transfer) or negative (retard transfer). Negative interaction effects may be sufficiently strong as to cause transfer reversal. 8 references, 4 figures, 2 tables.

4205 Materials Testing

REFER ALSO TO CITATION(S) 37440, 38542

38641 (LBL—21276) Applicability of the maximum likelihood estimator algorithm for image recovery in accelerated positron emitter beam injection. Llacer, J.; Andreae, S.; Chatterjee, A. (Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098. 11p. (CONF-8604213—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011303.

From International workshop on physics and engineering of computerized multidimensional imaging and processing; Newport Beach, CA, USA (2 Apr 1986).

The Maximum Likelihood Estimator (MLE) algorithm for tomographic image reconstruction is being investigated in substantial detail by a number of research groups, as it appears to promise images with very low noise and increased sharpness when compared with filtered backprojection techniques. Recently, however, it has been found that the reconstruction of data from uniform activity distributions exhibits strong peaks and valleys when the number of iterations increases toward a maximum in the likelihood function. This problem has now been investigated with our Positron Emitter Beam Analyzer (PEBA) camera, which, because of its small size and favorable geometry, has allowed an analysis with enough detail to find the origin of that apparent instability. The findings can be summarized as follows: The very low noise of the MLE reconstructions comes about by the ability of the Poisson-based MLE algorithm to generate an image which favors the matching of experimental data (detector pairs) containing few counts; the image instability at a high number of iterations is a direct consequence of the above characteristic; and the matrix of probability elements needed for the MLE reconstruction provides the link between the two above observed phenomena. It appears that, by proper system design, it is possible to obtain the favorable low noise characteristic without the instability. The applicability of the above findings to true tomography (PEBA does not carry out a true tomographic reconstruction) seems direct, but confirmation should be obtained by further research on the question.

4207 Vacuum Engineering

REFER ALSO TO CITATION(S) 37510, 38308, 38715

38642 Dissociative pumping of the alkanes using nonevaporable getters. Emerson, L.C.; Knize, R.J.; Cecchi, J.L.; Auciello, O. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 297-299(May 1986). Contract AC02-76CH03073.

The pumping speed of a standard Zr—Al getter was measured over a temperature range of 110 to 640 °C for the gaseous members of the alkane series (C/sub n/H/sub 2n/+2) extending from methane through n-butane. For a given member of the series, the pumping speed increases monotonically with temperature. The strength of the temperature dependencies decreases with increasing alkane mass. These data are in qualitative agreement with the predictions of a model which assumes that dissociation is the rate limiting process.

38643 Transfer leak studies and comparisons of primary leak standards at the National Bureau of Standards and Sandia National Laboratories. Hyland, R.W.; Ehrlich, C.D.; Tilford, C.R.; Thornberg, S. (National Bureau of Standards, Gaithersburg, Maryland 20899). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 334-337(May 1986).

Primary leak standards are being developed at the National Bureau of Standards (NBS), and a cooperative NBS—Sandia National Laboratories (SNL) program is underway to compare their different primary standards and investigate the properties of transfer leaks. Initial results of comparisons of the primary standards at the two laboratories, accomplished via sintered metal transfer leaks in the range 5×10^{-12} to 5×10^{-9} mol/s, show that the calibration methods used in the two laboratories agree to within a few percent for nitrogen, argon, and helium. Significant instabilities with time have been observed for one of the two leaks used in the comparison. Temperature coefficient data for helium diffusion leaks are presented which illustrate the possibility of significant errors when a linear temperature dependence is assumed over too wide a temperature range.

38644 Hot hollow cathode and its applications in vacuum coating: A concise review. Kuo, Y.S.; Bunshah, R.F.; Okrent, D. (KMS Fusion, Inc., Ann Arbor, Michigan 48106-1567). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 397-402(May 1986).

A concise description of the hollow cathode (HC) effect is given to clarify the confusing terminology and their diverse applications. The cold and hot types of HC's are then discussed. It is followed by a summary of the behavior of the hot HC as an arc generating device, with emphasis on its use for vacuum coating purposes. Two major coating devices, one developed by Ulvac Corp. (Japan) and the other at the Rocky Flats Plant (RFP) of Rockwell International (USA), are then reviewed with their respective applications. Review of the latter includes recent results of plume effect upon both the unusual deposition rate distribution and the extremely high substrate (ion) current. The coating morphology and microstructure can be best explained using the Krikorian concept and, when optimized, can help to render very high bonding strength (as high as 90 ksi for 304 stainless steel substrates), with the coatings used as the bonding interlayer. Finally, comments are made concerning the directions of future technology development based on the system features reviewed.

4208 Electronic Circuits And Devices

REFER ALSO TO CITATION(S) 38403, 38442, 38449, 38572

38645 (SAND—85-2748C) Development of a large-aperture PLZT shutter with enhanced operational/environmental capabilities. Harris, J.O. Jr.; Cutler, R.P.; Dulleck, G.R. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 6p. (CONF-8606121—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011643.

From International symposium on ultrasonics, ferroelectrics and frequency control; Bethlehem, PA, USA (9 Jun 1986).

PLZT thermal/flash protective shutters ranging in size from 25mm to 101mm in diameter have been developed by Sandia National Laboratories for industrial and military applications. A larger diameter shutter, 147mm, with enhanced environmental and operational capabilities was required for window ports. This paper describes a production PLZT shutter which provides these characteristics via the incorporation of new lens sealing techniques, packaging design, polarizers, and electronic subsystems.

38646 (SAND—86-0301C) TEMPO machine. Rohwein, G.J.; Lancaster, K.T.; Lawson, R.N. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1986. Contract AC04-76DP00789. 4p. (CONF-860674—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012283.

From 17. power modulator symposium; Seattle, WA, USA (23 Jun 1986).

TEMPO is a transformer powered megavolt pulse generator with an output pulse of 100 ns duration. The machine was designed for burst mode operation at pulse repetition rates up to 10 Hz with minimum pulse-to-pulse voltage variations. To meet the requirement for pulse duration a nd a 20-ω output impedance within reasonable size constraints, the pulse forming transmission line was designed as two parallel water-insulated, strip-type Blumleins. Stray capacitance and electric fields along the edges of the line elements were controlled by lining the tank with plastic sheet.

38647 (SAND—86-0434C) Engineering limits of photoconductive semiconductor switches in pulsed power applications. Zutavern, F.J.; O'Malley, M.W. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 6p. (CONF-860674—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012282.

From 17. power modulator symposium; Seattle, WA, USA (23 Jun 1986).

The potential of essentially jitter free subnanosecond rise time photoconductive semiconductor switches (PCSS) for pulsed power has been explored in several previous papers. In addition to picosecond rise time and jitter, PCSS also offers low inductance, high repetition rates (GBz), and optical control. In developing large scale PCSS for pulsed power applications, one encounters many aspects of the switch which can be selected or tailored to meet the specific requirements of each application. This paper describes PCSS in terms of the switching parameters which are being stressed to meet these requirements and discusses their theoretical limits as well as those encountered in the laboratory. Recent improvements (from 20 kV/cm to 70 kV/cm) in the surface breakdown strength of silicon wafers for high voltage PCSS are reported. Several specific examples are included to illustrate and emphasize the particular switching parameters being discussed.

38648 (SAND—86-0512C) Nanosecond spark gap switching measurements. Ginn, J.W.; Hendricks, D.N.; Buttram, M.T. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1986. Contract AC04-76DP00789. 5p. (CONF-860674—7). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012279.

From 17. power modulator symposium; Seattle, WA, USA (23 Jun 1986).

The switching time of gas and oil dielectric spark gaps was measured in the nanosecond and subnanosecond time regime. The observed switching characteristics of the two spark gaps were compared with those predicted by empirical formulas. The formulas used primarily were those developed in somewhat slower time regimes by J.C. Martin. For the given geometry, the switching times of both gaps were dominated by the resistive phase rather than by any inductive effects. The rise times observed from the output of the gas switch were consistently greater than those predicted for resistive phase duration in a gas spark. With charge times of from 50 to 60 ns to electric field values of from 170 to 350 kV/cm, 10% to 90% output rise times of from 2.8 to 8.2 .ıs were observed. The dielectric strength of the oil switch was consistent with the empirical prediction for oil breakdown. The oil gap was charged to electric field values of from 1.4 to 3.1 MV/cm with effective charge times of from 1.3 to 20 ns. Its output rise time was less than or equal to 400 ps. This result is not inconsistent with the empirical prediction for resistive phase duration in an oil spark. Measurement of times shorter than this were limited by the bandwidth of the available equipment.

38649 (SAND—86-0519C) Statistical distributions of breakdown voltages in a high current spark gap. Rinehart, L.F.; Buttram, M.T. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 8p. (CONF-860674—5). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012281.

From 17. power modulator symposium; Seattle, WA, USA (23 Jun 1986).

We have designed and constructed a new spark gap test-bed to study high current effects and to establish, experimentally, the critical current and other conditions required to generate the extreme value distribution. We are currently measuring the extreme value onset point as a function of current, gap spacing, and various other parameters. Scanning electron microscope study of electrode surfaces after discharges above and below the extreme value onset is being performed to correlate surface conditions with breakdown voltage distributions. The maximum design parameters of the test-bed are 140 kV, >100kA critically damped, >200 kA with ringing waveform, 14 kJ/shot, maximum available prime power 2 MW. A unique low inductance (230 nH with 1.4 μf energy storage) geometry is used to generate very high current discharges with no reversal; thus, anode-cathode effects may be studied separately at >100 kA. Test runs of $>10^4$ shots are performed for each set of experimental conditions so that very low probability events can be measured with confidence. These large statistical samples of data are recorded and analyzed by an on-line computer data acquisition system. We present here the machine design, geometry, and data showing the extreme value onset under some experimental conditions.

38650 (SAND—86-1160C) Effect of temperature on data retention of SNOS transistors. Miller, S.L. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 5p. (CONF-860872—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010953.

From 8. IEEE non-volatile semiconductor memory workshop; Vail, CO, USA (18 Aug 1986).

Understanding thermal effects on data retention of MNOS transistors is of fundamental importance in characterizing and predicting the behavior of fully functional parts in real environments. Much work, both theoretical and experimental, has been done in this area, with reasonable agreement being made between the two when appropriate assumptions were made. Most of this work was performed on metal gate, APCVD nitride, p-channel devices. The current paper studies temperature effects in modern Si gate, LPCVD nitride, n-channel transistors (the same transistors used in Sandia's SA2999-2, a 16K EEPROM with 5 year retention over the temperature range - 55 to 80°C utilizing 16V, 230μS/2500μS write/erase pulses). A major result of the present study is the fundamental difference in the response of the two logic states (trapped electrons vs trapped holes) in thermally varying environments. Here, the effects of hole trapping are not negligible, as has been the case of previous investigations on older technologies. Data are presented from our transistors which illustrate the fundamentally different ways that trapped electrons and holes respond to a thermally varying environment. Two primary cases are examined: (1) program at a fixed temperature and store at different temperatures, (2) program at different temperatures and store at a fixed temperature. The results are directly applicable to developing data retention

screens and for developing strategies to increase data retention time.

38651 (SAND—86-1379C) Reliability and electrical properties of gate oxide shorts in CMOS ICs. Hawkins, C.F.; Soden, J.M. (New Mexico Univ., Albuquerque (USA). Dept. of Electrical Engineering and Computer Science; Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 9p. (CONF-860996—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012168.

From IEEE international test conference; Washington, DC, USA (8 Sep 1986).

This paper examines the reliability of gate oxide shorts in CMOS ICs. Gate oxide shorts cause increased quiescent IDD but may not initially affect functionality. These shorts can subsequently change due to thermal and electric field stress during operation and cause functional failure. Therefore, gate oxide defects can significantly degrade CMOS IC reliability. 14 refs.

38652 (SAND—86-2079C) Reliability study of retention and memory gate integrity in a 1K MNOS RAM. Nasby, R.D.; Miller, W.M.; White, R.L. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 6p. (CONF-860872—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010483.

From 8. IEEE non-volatile semiconductor memory workshop; Vail, CO, USA (18 Aug 1986).

The reliability of a 1K MNOS RAM with regards to retention and nitride gate integrity has been demonstrated. Over 400 devices were screened and life tested to demonstrate 0.999 reliability during device life. The device was a 1K MNOS memory used in a RAM application with an erase/write cycle of 32 microseconds and a life specification of 1E7 cycles.

38653 (UCRL—92257) Pulsed laser planarization of metal films for multilevel interconnects. Tuckerman, D.B.; Schmitt, R.L. (Lawrence Livermore National Lab., CA (USA); Sandia National Labs., Livermore, CA (USA)). May 1985. Contract W-7405-ENG-48. 9p. (CONF-8506123—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012339.

From VLSI multilevel interconnection conference; Santa Clara, CA, USA (24 Jun 1985).

Multilevel interconnect schemes for integrated circuits generally require one or more planarization steps, in order to maintain an acceptably flat topography for lithography and thin-film step coverage on the higher levels. Traditional approaches have involved planarization of the interlevel insulation (dielectric) layers, either by spin-on application (e.g., polyimide), or by reflow (e.g., phosphosilicate glass). We have pursued an alternative approach, in which each metal level is melted (hence planarized) using a pulsed laser prior to patterning. Short ($\sim$1 μs) pulses are used to preclude undesirable metallurgical reactions between the film, adhesion or barrier layer, and dielectric layer. Laser planarization of metals is particularly well suited to multilevel systems which include ground or power planes. Results are presented for planarization of gold films on SiO_2 dielectric layers using a flashlamp-pumped dye laser. The pulse duration is $\sim$1 μs, which allows the heat pulse to uniformly penetrate the gold while not penetrating substantially through the underlying SiO_2 (hence not perturbing the lower levels of metal). Excellent planarization of the gold films is achieved (less than 0.1 μm surface roughness, even starting with extreme topographic variations), as well as improved conductivity. To demonstrate the process, numerous planarized two-layer structures (transmission lines under a ground plane) were fabricated and characterized. 9 refs., 2 figs.

38654 (UCRL—94757) Alternator-driven, magnetically switched modulator. Kihara, R.; Kirbie, H.C. (Lawrence Livermore National Lab., CA (USA)). 1986. Contract W-7405-ENG-48. 8p. (CONF-860674—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012189.

From 17. power modulator symposium; Seattle, WA, USA (23 Jun 1986).

The technique of magnetically switching high-power pulses, first summarized by Melville many years ago, was recently revitalized with the development of amorphous magnetic alloys and the new power conditioning requirements of pulsed lasers and high-brightness particle accelerators. The most common magnetic switching technique for generating high-repetition-rate pulses is shown in Fig. 1(a) and consists of a dc power supply, a triggered switch (thyratron or solid-state), and a repeated network of magnetic switches and capacitors. The life of this type of pulser is limited by the aging of liquid and solid dielectric materials and by the reliability of the triggered switch. An alternator-driven, magnetically switched modulator differs from the conventional magnetic modulator in the replacement of the dc power supply and triggered switch with a high-frequency motor-generator set and an all-magnetic circuit, as shown in Fig. 1(b). The power conditioning network converts each cycle of the applied ac power into a single, compressed, unipolar pulse. Consequently, the modulator produces a train of pulses with an interpulse separation equal to the period of the alternator. Additional compression can be attained by the addition of successive stages of magnetic switching. The absence of active switches within the network improves the system reliability and extends the service life of the modulator to the limits of component insulation fatigue and alternator bearing wear. This style of magnetic pulse compression was first described by Melville and reproduced at LLNL in order to quantify the network efficiency, jitter and reliability when modern magnetic materials are employed.

38655 Theory of response of radiation sensing field-effect transistors in zero-bias operation. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Applied Physics;* 60: No. 3, 1216-1217(1 Aug 1986). Contract AC04-76DP00789.

Radiation sensing field-effect transistors operated at zero bias show a low-dose response that is roughly linear in the thickness of the gate oxide. The same devices show a thickness squared dependence if a bias is applied during the irradiation. This effect can be explained by examining the effect of diffusion and electron trapping on the buildup of net positive charge in the gate oxide.

38656 Generation and measurements of ion species from vacuum arcs. Len, L.K.; Burkhart, C.; Cooper, G.W.; Humphries, S.; Savage, M.; Woodall, D.M. (Inst. for Accelerator and Plasma Beam Technology, Dept. of Chemical and Nuclear Engineering, Univ. of New Mexico, Albuquerque, NM 87131). *IEEE (Institute of Electrical and Elec.ronics Engineers) Transactions on Plasma Science;* PS-14: No. 3, 256-260(Jun 1986).

The authors have measured the ion flux for different electrode materials in a vacuum arc. The vacuum arc has a point-plane geometry. The ion species in the generated plasma are identified using a time-of-flight (TOF) spectrometer. Ion species that have been generated to date include D^+, Mg^+, Mg^{++}, Al^+, Al^{++}, Al^{+++}, Ti^+, Ti^{++}, Ni^+, Ni^{++}, Cu^+, Cu^{++}, Zn^+, Zn^{++}, and In^+. In all cases, the ion flux measured is directly proportional to the interelectrode gap spacing and to the arc current. Typical current densities measured were $\approx$300 mA . cm^{-2} at a distance of 10 cm from the gap for 150-μpulse. The study will be used for the development of a multiple-arc array source for application to intense ion beam generation.

38657 Capacitor charging fet switcher with controller to adjust pulse width. Mihalka, A.M. (to Dept. of Energy, Washington, DC). US Patent 4,586,118. 29 Apr 1986. Filed date 5 Jun 1984. vp.

A switching power supply for charging a capacitive load is described which consists of: a step-up transformer having its secondary connected to the load; four power MOSFETs arrayed in a full bridge configuration connected to the primary of the step-up transformer; control means connected to the MOSFETs for alternately switching on and off diagonal pairs of the MOSFETs; soft start means connected to the control means for periodically adjusting pulse width to maintain approximate peak current to the load, the soft start means comprising a timing capacitor, parallel timing resistors of different values connected to the timing capacitor, and selection means for sequentially selecting one of the timing resistors for discharging the timing capacitor with a time constant determined by the value of the selected timing resistor.

38658 DC switching regulated power supply for driving an inductive load. Dyer, G.R. (to Dept. of Energy, Washington, DC). US Patent 4,585,986. 29 Apr 1986. Filed date 29 Nov 1983. vp.

A switching regulated DC power supply is described for regulating the direct current to an inductive load. The power supply consists of: a dc power source; an inductive load; a bridge circuit including first and second input terminals connected respectively to opposite polarity terminals of the power source, first and second output terminals of corresponding polarity to the first and second input terminals connected across the load, a first unidirectional current conducting switching means forming a first leg of the bridge circuit for conducting current from the first input terminal to the first output terminal in response to a first control signal applied to a control input thereof, a second unidirectional current conducting switching means forming a second leg of the bridge circuit for conducting current from the second output terminal to the second input terminal in response to a second control signal applied to a control input thereof, a first diode device connected between the first input terminal and the second output terminal to allow load current to flow therethrough when the second switching means is switched off and a second diode device connected between the second input terminal and the first output terminal to allow load current to flow therethrough when the first switching means is switched off so that when both of the first and second switching means are switched on current flows from the source to the load when the first and second switching means are switched off current flows from the load to the source.

38659 Spectroscopic measurements of the electric field and ion transverse velocities in a magnetically insulated ion diode. Coleman, M.D.; Maron, Y.; Hammer, D.A. (Cornell Univ.). pp 2Q-1 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AS08-81DP40139.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Excited C^{++} and Al^{++} ions produced in the surface flashover plasma in a magnetically insulated diode have been used to measure the electric field and ion transverse velocities in the acceleration gap by spectroscopic techniques. The emission lines of ions traversing the gap are Stark shifted from their natural wavelength because of the diode electric field; this allows a determination of the electric field as a function of distance across the gap by appropriate choice of an ion line to observe. If the light is viewed transverse to the acceleration direction, the width of lines which are not Stark shifted will be mostly determined by Doppler broadening due to the ion transverse velocities. The authors use the OMNI II generator (up to 500kV, 25kA, 80 nsec), with a planar diode, an insulating field of 5-10 kG and an A-K gap spacing of 6-9 mm. Surface flashover on a sheet of polyethylene covering the anode is the source of the anode plasma and provides a source for the C^{++} ions. The cathode is made of Al and the source of the Al^{++} ions accelerated across the gap is Al which has been blown off the cathode and deposited on the anode. The diode has been operated both with and without metal vanes projecting 3.5 mm from the cathode; the vanes emit electrons which form a virtual cathode in front of the real cathode. The light from the entire 6cm x 14cm area in front of the polyethylene anode is viewed parallel to the applied B field. A spectral resolution of 0.75A is obtained by dispersing the light using a spectrometer followed by 6 optical fiber bundles attached to PM-tubes. A complete spectral line profile of a C^{++} or Al^{++} line is obtained on a single discharge at a given distance from the anode surface. Stark shift measurements were obtained with two Al^{++} 4d → 4p transitions (4529A and 4512A).

38660 Backward wave oscillators with rippled wall resonators: Analytic theory and numerical simulation. Swegle, J.A.; Poukey, J.W. (Sandia National Labs., Albuquerque, NM). pp 1B-3 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC04-76DP00789.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The 3-D analytic theory is based on the approximation that the device is infinitely long. In the absence of an electron beam, the theory is exact and allows us to compute the dispersion characteristics of the cold structure. With the inclusion of a thin electron beam, we can compute the growth rates resulting from the interaction between a waveguide mode of the structure and the slower space charge wave on the beam. In the limit of low beam currents, the full dispersion relation based on an electromagnetic analysis can be placed in correspondence with the circuit theory of Pierce. Numerical simulations permit us to explore the saturated, large amplitude operating regime for TM axisymmetric modes. The scaling of operating frequency, peak power, and operating efficiency with beam and resonator parameters is examined. The analytic theory indicates that growth rates are largest for the TM_{01} modes and decrease with both the radial and azimuthal mode numbers. Another interesting trend is that for a fixed cathode voltage and slow wave structure, growth rates peak for a beam current below the space charge limiting value and decrease for both larger and smaller currents. The simulations show waves that grow from noise without any input signal, so that the system functions as an oscillator. The TM_{01} mode predominates in all simulations. While a minimum device length is required for the start of oscillations, it appears that if the slow wave structure is too long, output power is decreased by a transfer of wave energy back to the electrons. Comparisons have been made between the analytical and numerical results, as well as with experimental data obtained at Sandia National Laboratories.

4209 Waste Processing Plants And Equipment

38661 (STEV-SB—86-2) Shredder, mainly for industrial waste. Final report. Frisk, E. (Statens Energiverk, Stockholm (Sweden)). 1986. 10p. (In Swedish). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752273.

The shredder prototype has at tests, and modifications made in connection therewith, shown that the design has essentially corresponded to the expectations. Further experience may show possibilities to additional improvements. The results according to specifications regarding expected capacity, 5-10 m^3a/h, has been reached, as well as the maximum size of the waste chips, 50-60 mm. The capacity can anyhow simply be changed by varying the open space in the grate. The size of the produced waste chips can also simply be changed by variation of the openings in the grate. The aim regarding number of moving parts, spare parts and wear parts has been fulfilled. During the testing period the prototype has been working without any kind of special foundation. The influence of the rotor on stability and manner of action has been studied at 17 and 23 rpm. Appropriate standard sizes for required power seems to be 7.5, 11, and 15 kW. Because of the short testing time the avialability has not been studied enough. A considerable reduction of the power input has been the most pronounced result of the modifications made during the shredders test stand. (author).

4210 Combustion Systems

REFER ALSO TO CITATION(S) 37376, 37700, 38195, 38299, 38375, 38536, 38631, 38633

38662 (EUR—10080-EN) Survey of combustion research in the European Community. Dale, B.W.; Hartley, N.E.W.; Hutchinson, P. (Commission of the European Communities, Luxembourg. Directorate General Information Market and Innovation). 1985. 187p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energy.

This survey on combustion research was undertaken by the Harwell Combustion Centre on behalf of the European Community, Directorate-General for Science, Research and Developemnt, Non-nuclear Energy R and D Programme. The survey presents the outcome of interviews with scientists working in combustion research in the Member States of the European Community. The survey of the status of combustion research covers areas - "Steady state" combustion in furnances; - Combustion in automotive en-

gines, and includes a full range of topics like combustion kinetics, soot and smoke formation, emission control, 3-dimensional modelling of turbulent flow and optical diagnostics. A preliminary synopsis is given of what is being undertaken and needs to be done in the long-term in this field in the Member State of the European Community. (orig./GL).

38663 (EUR—10088-EN) Construction, operation and optimisation of a furnace for the economic burning of low calorific value gases. Final report. Claypole, T.C.; Syred, N. (University Coll., Cardiff (UK)). 1985. 257p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energy.

Low calorific value gases are often produced as a by-product of industrial processes. Such gases represent a readily available source of energy for process requirements in the European Community. This project has successfully demonstrated the potential of swirl burner/furnace systems to efficiently burn and recover heat from low calorific value gases of various composition. There were three main areas of research and development in this project: The development of a small 100 kW unit on site and in the laboratory which proved the systems feasibility for incinerating the discharge gases at the Phurnacite works, Mountain Ash and provided sufficient data to enable a full scale system to be designed. A study of the fundamental combustion processes when a swirl burner is fired into a narrow cylindrical furnace using a 100 kW model. The design and construction of an industrial scale-unit (approx. 1.5 MW Thermal capacity) in the University. (orig.).

38664 (N—86-21817) Demonstration test of burner liner strain measuring system. Final Report. Stetson, K.A. (United Technologies Research Center, East Hartford, CT (USA)). Jun 1984. 96p. (NASA-CR—174743). NTIS, PC A05/MF A01.

A demonstration test was conducted for two systems of static strain measurement that had been shown to have potential for application jet engine combustors. A modified JT12D combustor was operated in a jet burner test stand while subjected simultaneously to both systems of instrumentation, i.e., Kanthal A-1 wire strain gages and laser speckle photography. A section of the burner was removed for installation and calibration of the wire gages, and welded back into the burner. The burner test rig was modified to provide a viewing port for the laser speckle photography such that the instrumented section could be observed during operation. Six out of ten wire gages survived testing and showed excellent repeatability. The extensive precalibration procedures were shown to be effective in compensating for the large apparent strains associated with these gages. Although all portions of the speckle photography system operated satisfactorily, a problem was encountered in the form of optical inhomogeneities in the hot, high-pressure gas flowing by the combustor case which generate large and random apparent strain distributions.

38665 (PB—86-190733/XAB) Pulse-combustion space-heater field-test-unit design. Topical report, February 1985-January 1986. West, J.L.; Thrasher, W.H. (American Gas Association Labs., Cleveland, OH). Jan 1986. 27p. NTIS, PC A03/MF A01.

A 20,000 Btu/hr direct-vent pulse-combustion space heater that operates at steady-state thermal efficiencies in excess of 90% was developed. A new participating manufacturer joined the project in February, 1985 and supplied design requirements that served as the basis for the subsequent development work at A.G.A.L. Due to differences in the manufacturing capabilities of the original and present participating manufacturers, the combustor system and many other components were significantly redesigned. Efforts were also made to incorporate the manufacturer's marketing requirements into the design. An exhaust decoupler is included in the combustor design so that the space heater may be installed at lengths up to 15 feet from the vent termination. The model was designed to be free standing rather than wall mounted with a removable circulating air filter that may be cleaned by the occupant. Humidification of the circulating air is achieved by evaporating condensate collected in a pan at the bottom of the inner cabinet. Results of field testing of the initial prototypes indicated the importance of minimizing the overall sound pressure level of the unit. A tangential blower was incorporated in the design to decrease the contribution of the circulating air-blower noise to the overall sound level.

38666 (PB—86-191483/XAB) Environmental assessment of an enhanced-oil-recovery steam generator equipped with an EPA (Environmental Protection Agency) heavy oil low-NOx burner. Volume 2. Data supplement. Final report, January 1984-January 1985. Castaldini, C.; Waterland, L.R.; DeRosier, R. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Apr 1986. 189p. NTIS, PC A09/MF A01.

The report gives results of comprehensive emission measurements and 30-day flue-gas monitoring on a 16-MW (55 million Btu/hr) enhanced-oil-recovery steam generator equipped with the EPA low-NOx burner firing high-nitrogen crude.

38667 Method to measure the fuel distribution and the fuel captured by V-gutter flameholder in high speed airstream. Gu, S.J.; Yang, M.L.; Li, X.Y. (Beijing Institute of Aeronautics and Astronautics, People's Republic of China). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

A method to measure the fuel distribution and the percentage of fuel flow rate captured by a V-gutter flameholder in a high speed airstream has been developed. The effects of configuration and size of the probe and temperature of the sample mixture in the probe on measurement have been investigated. The detailed determination of isokinetic sampling condition is described. The effects of V-gutter geometry on flowfield have been considered. The total experimental error is of the order + or - 5 percent. 5 references.

38668 Dual-orifice atomizer performance under varying air density conditions. Jasuja, A.K. (Cranfield Institute of Technology, England). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

The spray quality and spatial distribution characteristics of a pressure atomizer of the dual-orifice type have been experimentally investigated using the well-established, non-intrusive techniques of laser droplet sizing and photography. Tests were conducted on kerosine and gas oil at air pressures up to about 8 atmospheres. The characteristics of spray quality and spatial distribution have been shown to undergo a noticeable change over a wide range of main fuel flows. An increase in the air-density results in an improvement in the spray quality, but, is accompanied with a reduction in spray penetration. The dropsize correlation evolved earlier for the simplex pressure atomizer has been applied with success to the dual-orifice atomizer featured in this investigation. 13 references.

38669 Full coverage discrete hole film cooling - the influence of hole size. Andrews, G.E.; Asere, A.A.; Gupta, M.L.; Mkpadi, M.C. (Leeds Univ., England). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

The influence of hole size and hence blowing rate on full coverage discrete hole wall cooling for gas turbine combustion chamber applications was investigated. Two temperature conditions were used first, a 750 K gas temperature and 300 K coolant, and secondly a realistic combustor primary zone conditions of 2100 K flame temperature and 700 K coolant. It was shown that a large hole size resulted in a significant improvement in the overall cooling effectiveness due to a reduced film heat transfer coefficient. At high temperature the cooling effectiveness was reduced due to radiative heat transfer from the flame gases. At low coolant flow large temperature increases of the coolant occurred within the wall and approached the transpiration situation. 17 references.

38670 Experimental study of the mixing by an acoustically pulsed axisymmetrical air-jet. Vermeulen, P.J.; Yu, W.K. (Calgary Univ., Canada). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

The mixing by an acoustically pulsed axisymmetrical air jet, flowing into the atmosphere, has been studied by means of velocity and temperature profile measurements. The strength of the velocity pulsation imparted to the jet flow and of the associated toroidal vortices were also measured. The entrainment rate was increased by up to two times, with the majority of the extra entrainment occurring over the first five diameters downstream of the jet orifice, where toroidal vortices are formed and attain their greatest strength. The jet response depends on Strouhal number and appears to be optimum at about 0.25. The response starts to saturate at the limit of pulsation strength used. 24 references.

38671 Conical grid plate flame stabilizers for combustor primary zones. Ali, A.F.; Andrews, G.E. (Leeds Univ., England). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

Emission results are presented for a jet shear layer flame stabilizer design consisting of a 90 deg conical flame stabilizer with an array of holes and a central annular vaporizer fuel injection system. This design was tested with premixed propane and air and with direct propane injection into the vaporizer at two blockages and approach velocities. The results showed that an array of jet shear layers could be fuelled by a single fuel injector without incurring excessive NO(x) emissions. An increase in the primary zone residence time was found to result in an improved combustion efficiency, with no increase in NO(x), provided that the stabilizer blockage was increased to maintain the pressure loss.

38672 Low-temperature hot corrosion in gas turbines - a review of causes and coatings transfer. Goward, G.W. (Turbine Components Corp., Branford, CT). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

In about 1975 an apparently new form of hot corrosion attack of gas turbine airfoils was identified during low-power, low-metal-temperature operation of a marine gas turbine. The rate of this corrosion was substantially greater at about 700 C than that usually observed for sulfate-induced hot corrosion at 800 to 1000 C. The same type of hot corrosion has been subsequently reported to occur in ground-based gas turbines and is similar in principle to fireside corrosion of boiler tubes. This paper presents a review of probable mechanisms of this so-called low-temperature hot corrosion, of test methods for its laboratory and rig simulation, and of coatings in use or in advanced development for protection of gas turbine airfoils operating in this corrosion regime. 35 references.

38673 Heat transfer results and operational characteristics of the NASA Lewis Research Center hot section cascade test facility. Gladden, H.J.; Yeh, F.C.; Fronek, D.L. (NASA, Lewis Research Center, Cleveland, OH). *Archivio per le Scienze Mediche;* vp(Mar 1985). (CONF-850351—).

From 30. international gas turbine conference and exhibit; Houston, TX, USA (18 Mar 1985).

The NASA Lewis Research Center gas turbine hot section test facility has been developed to provide a real-engine environment with well known boundary conditions for the aerothermal performance evaluation/verification of computer design codes. The initial aerothermal research data obtained are presented and the operational characteristics of the facility are discussed. This facility is capable of testing at temperatures and pressures up to 1600 K and 18 atm which corresponds to a vane exit Reynolds number range of 0.5 x 1 million to 2.5 x 1 million based on vane chord. The component cooling air temperature can be independently modulated between 330 and 700 K providing gas-to-coolant temperature ratios similar to current engine application. Research instrumentation of the test components provide conventional pressure and temperature measurements as well as metal temperatures measured by IR-photography. The primary data acquisition mode is steady state through a 704 channel multiplexer/digitizer. The test facility was configured as an annular cascade of full coverage film cooled vanes for the initial series of research tests. 8 references.

4230 Marine Engineering

REFER ALSO TO CITATION(S) 37410, 37411

38674 (CONF-8404306—, pp 301-309) **Fiber optics in subsea control systems.** 1984. NTIS (US Sales Only), PC A20/MF A01. File Number DE86752136.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

Present control systems for subsea production installations use either hydraulic lines for remote control of valves etc., or a combination of hydraulics and electrical lines. In the letter, signals to and from the subsea structures are transmitted on electrical lines, while hydraulics is used for transfer of power for opening and closing of valves. Fiber optics subsea offers the potential for a wider application of control and monitoring facilities with possibly improved reliability characteristics. A research program has been carried out since 1981 for several oil companies to develop an test out a fiber optics system for potential use on a subsea control system. The aim is to replace electrical metal cables with glass fibers carrying light signals. Fiber optics transmission systems are today well developed for land-based communications, and they are also being considered for use on offshore topside facilities. The application of fiber optics for subsea production control does however pose special problems, because the systems must be built to survive subsea for 25 years, and they must also have one or more subsea make/break connectors. 5 references.

38675 (CONF-8404306—, pp 329-336) **Deep diver intervention - challenges and limitations.** 1984. NTIS (US Sales Only), PC A20/MF A01. File Number DE86752136.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

The development of deep water fields on the Norwegian continental shelf will be determined by several factors including available underwater technology. This may cause changes and/or delays in the current time-tables for production. The immediate new demands for underwater operations will be at depths down to 300-400 m below sea-level. So far, sub-sea equipment has been developed without sufficient consideration of the underwater operations needed for inspection, maintenance and repair. To perform these tasks one or more of the following techniques will have to be involved: hyperbaric diving, unmanned vehicles, manned vehicles. dry/wet atmospheric sea-bed and sub-sea units, modular equipment exchangeable from the surface and finally robot systems. For the time being, not one system is capable of covering all aspects of the underwater operations, and a combination of different approches is likely to be required. 17 references.

38676 (CONF-8404306—, pp 391-400) **OCTOPUS - a general system for underwater navigation within structures.** 1984. NTIS (US Sales Only), PC A20/MF A01. File Number DE86752136.

From Underwater technology conference; Bergen, Norway (9 Apr 1984).

The extensive underwater operations concerning inspection and maintenance of offshore production platforms have long been recognized. Reliability, safety and economic aspects of such operations have motivated increased attention on cost effective technical aids for navigation and positioning of a vehicle or a diver within or in the vicinity of offshore structures. The structure may be a steel jacket, a concrete platform or another type of structure. The problems of reverberation and background noise in such environments are shortly described. A prototype system, OCTOPUS, has been developed and the field test of it is described. The test results show that the accuracy of the prototype system is quite near the requirements of +/-10cm, even with background noise levels well above what can be expected in an offshore environment. Finally, plans for further development of the system are mentioned.

38677 (NP—6752107) Danish submarine pipeline guidelines. First draft. Hinstrup, P.I.; Colquhoun, R.S.; Gravesen, H. (Ramboell og Hannemann, Raadgivende Ingenioerer A/S, Odense (Denmark)). Jul 1985. 183p. NTIS (US Sales Only), PC A09/MF A01. File Number DE86752107.

The purpose of the exercise of which the draughting of this provisional guideline forms part is to prepare a complete guide covering the engineering, the supervision of manufacure and construction, and the subsequent inspection and maintenance of submarine pipelines. The manual should incorporate the newest technological developments with a view to introducing the application of more reliable engineering methods thereby achieving cheaper works coupled with greater safety. The new manual should figure internationally as an advanced supplement to the existing codes insofar as concerns submarine pipelines. It is intended as a basis for constructive dialogue rather than as a closed definitive prescription. The ultimate objective behind this is partially to achieve a rationalisation of the engineering of future Danish submarine pipeline works and partially to place the expertise developed in Denmark at the disposal of the world at large. For a large number of subjects it is possible to prepare guideline material solely by drawing up a status based on experience to date. For other subjects additional clarification is needed before final guideline material can be draughted.

4240 Pollution Control Equipment

REFER ALSO TO CITATION(S) 38832

38678 (LBL—21449) Fourier transform infrared spectroscopy (FTIR) ammonium sulfate analysis on teflon air filters. Pollard, M.J.; Jaklevic, J.M. (Lawrence Berkeley Lab., CA (USA)). Apr 1986. Contract AC03-76SF00098. 15p. (CONF-860426—5). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012497.

From Symposium on measurement of toxic air pollutants; Raleigh, NC, USA (27 Apr 1986).

This paper reports on the improvement and automation of a method of analyzing ammonium sulfate particles collected on Teflon membrane filters. The filters were analyzed by transmission measurements using Fourier transform infrared spectroscopy after collection with dichotomous air samplers. The spectra of the blank filters are subtracted from the spectra of the loaded filters and an integration of the 1000 to 1135 cm^{-1} absorbance band for sulfate leads to a lower limit of detection of 0.2 $\mu g/cm^2$ on 37 mm 2 micron Teflon filters. This corresponds to an ambient concentration of $\mu g/m^3$ for a 24 hr, 21.6 m^3 air sample. Ammonium sulfate particulate standards were prepared by sampling the output of a laboratory particle generator. Concentrations were then determined by x-ray fluorescence analysis. An automatic sample changer was constructed which accepts the filter carousel from a Sierra/ Anderson model 245 automated dichotomous sampler. The sample changer is controlled by the FTIR computer. The analysis is nondestructive, automated, and requires no sample preparation.

38679 (NP—6752098) Final report on the development project Flue Gas Cleaning. Petersen, L.-L. (Niro Atomizer A/S, Soeborg (Denmark)). [1985]. 132p. (In Danish). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752098.

Niro Atomizer has received State aid for projects under the Energy Research Programmes EFP 82 and EFP 83. The purpose of the projects has been to develop process modifications to Niro Atomizer's already existing desulphurization process, which should make it possible also to remove nitrogen oxides from flue gases containing both SOsub(x) and NOsub(x). Tests have been performed in lab-scale as well as full-scale. The testwork has resulted in the development of a process for simultaneous absorption of SOsub(x) and NOsub(x). A spray absorber followed by a bag filter is used in the process. The process is especially suited for cleaning of flue gases from high sulphur coal. Removal of more than 90% SO_2 and more than 50% NOsub(x) have beem achieved. A thermal window occurs for the SOsub(x)/NOsub(x)-process in the interval from 90 to 110 deg C. A rough sketch of the reaction mechanism under the SOsub(x)/NOsub(x)-reaction has been made. Under certain operation conditions the stack plume may be yellow due to considerable NO_2-formation in the system. Investigations will be made to find process modifications to avoid considerable NO_2 concentrations, thus making it possible to treat flue gases from low sulphur coal. Thorough product analyses will be carried out to identify compounds, which are developed under the reaction.

38680 (NP—6752269) Determination of size and velocity of flue gas particulates. Gruener Hanson, S.; Rasmussen, E.; Cortzen, F.; Ethelfeld, J.; Olsen, A. (Risoe National Lab., Roskilde (Denmark)). Dec 1985. 130p. (In Danish). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752269.

A system for simultaneous size- and velocity measurement of irregularly shaped soot particles has been designed and built. The velocity determination is based on a "Time/of/flight Laser Anemometer" and the size determination is based on transit time measurement of particles traversing a thin foil of light. An electronical processor based on "Maximum Likelihood" principles has been built. The system has proven its ability to determine particle sizes from 7 um to 200 um in air flows of velocities of up to 3 m/sec. (author).

4250 Power Cycles

REFER ALSO TO CITATION(S) 37769, 37947

38681 (LA-UR—86-1548) Liquid metal thermoacoustic engine. Swift, G.W.; Migliori, A.; Wheatley, J.C. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-860810—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011264.

From Intersociety energy conversion engineering conference; San Diego, CA, USA (25 Aug 1986).

We are studying a liquid metal thermoacoustic engine both theoretically and experimentally. This type of engine promises to produce large quantities of electrical energy from heat at modest efficiency with no moving parts. A sound wave is usually thought of as consisting of pressure oscillations, but always attendant to the pressure oscillation are temperature oscillations. The combination produces a rich variety of "thermoacoustic" effects. These effects are usually so small that they are never noticed in everyday life; nevertheless under the right circumstances they can be harnessed to produce powerful heat engines, heat pumps, and refrigerators. In our liquid metal thermoacoustic engine, heat flow from a high temperature source to a low temperature sink generates a high-amplitude standing acoustic wave in liquid sodium. This acoustic power is converted to electric power by a simple magnetohydrodynamic effect at the acoustic oscillation frequency. We have developed a detailed thermoacoustic theory applicable to this engine, and find that a reasonably designed liquid sodium engine operating between 700°C and 100°C should generate about 60 W/cm^2 of acoustic power at about 1/3 of Carnot's efficiency. Construction of a 3000 W-thermal laboratory model engine has just been completed, and we have exciting preliminary experimental results as of the time of preparation of this manuscript showing, basically, that the engine works. We have also designed and built a 1 kHz liquid sodium magnetohydrodynamic generator and have extensive measurements on it. It is now very well characterized both experimentally and theoretically. The first generator of its kind, it already converts acoustic power to electric power with 40% efficiency. 16 refs., 5 figs.

43 PARTICLE ACCELERATORS

4301 Design, Development, And Operation

REFER ALSO TO CITATION(S) 38856

38682 (DOE/SF/00515—T64) Stanford Linear Accelerator Center monthly report for May 1986. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). 1986. Contract AC03-76SF00515. 23p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012315.

Operational activities for the month of May 1986 are reported in the areas of accelerator and research operations, research area and experiment status, accelerator improvements, research division developments, PEP division developments, and publications for the month. (LEW)

38683 (LA-UR—86-2138) Physics with bottled antiprotons. Hynes, M.V.; Campbell, L.C. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 11p. (CONF-8604201—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012400.

From Antimatter physics at low energies; Batavia, IL, USA (10 Apr 1986).

The same beam cooling techniques that has allowed for high luminosity antiproton experiments at high energy also provides the opportunity for experiments at ultra-low energy. Through a series of deceleration stages, antiprotons collected and cooled at the peak momentum for production can be made available at thermal or subthermal energies. In particular, the Los Alamos collaboration is developing an RFQ-pulsed ion trap beam line for the antiproton gravitational mass experiment (PS200) at LEAR that will provide beams of antiprotons in the energy range 0.001 to 1000.0 eV. Antiprotons at these energies make these fundamental particles available for experiments in condensed matter and atomic physics. The recent speculation that antiprotons may form metastable states in some forms of normal matter could open many new avenues of basic and applied research. 5 refs.

38684 (LBL—21182) Present status of the Bevalac and design outline of proposed medical accelerator. Gough, R.A. (Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012835.

The Bevalac currently supports a strong and diverse program of scientific research with beams of relativistic heavy ions in the Biomedical and Nuclear Sciences. These programs utilize ions throughout the Periodic Table that range in energy from a few MeV to 2 GeV/nucleon, including radioactive secondary beams, such as neon-19. This paper first provides a brief overview of the Bevalac, its present operational status and the accelerator improvement program, followed by a rationale for the proposed construction of a hospital-based modern synchrotron dedicated to applications in Biomedicine, including the radiotherapeutic treatment of cancer and other human disorders. An outline of the proposed design for the new machine is given, including discussion of the design philosophy, a review of major accelerator components, and the expected performance and operating characteristics.

38685 (SAND—86-1240C) Experimental investigation of beam generation, acceleration, transport and extraction in the RADLAC-II pulsed transmission line linear accelerator. Mazarakis, M.G.; Leifeste, G.T.; Shope, S.L.; Frost, C.A.; Freeman, J.R.; Poukey, J.W.; Stygar, W.A.; Ekdahl, C.A.; Smith, D.L.; Johnson, D.L. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 13p. (CONF-8605143—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011826.

From LINAC '86: logistics meeting; Stanford, CA, USA (31 May 1986).

We have investigated the generation, acceleration, transport, and extraction of intense, high-voltage, relativistic electron beams with the RADLAC-II accelerator. A 40-kA, electron beam was produced by a foilless diode injector, which was immersed in, and accurately aligned with, the magnetic axis of a 17-kG solenoidal guide field. The solenoidal field guides the beam through the accelerator, which includes a number of post-accelerating gaps designed to provide radial force balance to suppress radial oscillations. Furthermore, the accelerating cavities have a very low Q and small transverse shunt impedance to suppress beam breakup instabilities. A 70% to 90% transport efficiency was observed, depending on the precision of the beam line alignment. Finally, the beam was extracted, without significant losses, and propagated into a magnetic field-free, air-filled region.

38686 (SLAC-PUB—3974) Status of the SLC. Moffeit, K.C. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). May 1986. Contract AC03-76SF00515. 9p. (CONF-860150—4). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012043.

From Winter condensed matter physics conference: frontiers in condensed matter X-ray physics; Aspen, CO, USA (12 Jan 1986).

The goals of the SLAC Linear Collider, SLC, are to develop the techniques of linear colliders and to do physics at and slightly above the energy necessary to produce the Z^0. A short review is given of the physics goals of the SLC, followed by the status of the SLC and its detectors. Plans for accelerating polarized electrons at SLC are also discussed. 6 figs. (LEW)

38687 Operator interface to the ORIC control system. Ludemann, C.A.; Casstevens, B.J. (Oak Ridge National Lab., Oak Ridge, TN). pp 491-496 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—). Contract W-7405-ENG-26.

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

The Oak Ridge Isochronous Cyclotron (ORIC) was built in the early 1960s with a hard-wired manual control system. Presently, it serves as a variable-energy heavy-ion cyclotron with an internal ion source, or as an energy booster for the new 25 MV tandem electrostatic accelerator of the Holifield Heavy Ion Facility. One factor which has kept the cyclotron the productive research tool it is today is the gradual transfer of its control functions to a computer-based system beginning in the 1970s. This particular placement of a computer between an accelerator and its operators afforded some unique challenges and opportunities that would not be encountered today. Historically, the transformation began at a time when computers were just beginning to gain acceptance as reliable operational tools. Veteran operators with tens of years of accelerator experience justifiably expressed skepticism that this "improvement" would aid them, particularly if they had to re-learn how to operate the machine. The confidence of the operators was gained when they realized that one of the primary principles of ergonomics was being upheld. The computer software and hardware was being designed to serve them and not the computer. The undertaking, in fact, was aided by information not usually available when one designs a new accelerator and control system simultaneously. The idiosyncracies of the accelerator were well-known and the areas in which the computer could provide assistance were readily identifiable. Furthermore, the operators had developed "natural" tuning techniques that a system designer would not necessarily have thought of. Typically, in a new installation these aspects are discovered only after a few years of operating experience. It is usually within the first revision of the software (but hopefully not the hardware) that trouble spots are eliminated and unanticipated features added.

4302 Beam Dynamics, Field Calculations, And Ion Optics

REFER ALSO TO CITATION(S) 38710

38688 (FNAL-TM—1381-A) Elliptic distribution in longitudinal phase space (supplement to TM-1381, "The beam and the bucket"). Ohnuma, S. (Fermi National Accelerator Lab., Batavia, IL (USA)). Apr 1986. Contract AC02-76CH03000. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012597.

As an alternative to either the uniform distribution (which is not really physical) or the Gaussian distribution (which is not finite), a finite distribution called "elliptic" is proposed and its main properties are presented. With canonical variables q triple bonded phi-phi/sub s/,y proportional to $\Delta p/p$), this distribution takes the form rho(q,y) proportional to $\sqrt{y/\text{sub } B/^2(q) - y^2}$ where y/sub B/(q) defines the boundary of a finite bunch in (q,y) space. It is assumed that the boundary is determined by the condition "Hamiltonian in (q,y) = constant" so that the shape is in general not symmetric in phase. This report is intended as a supplement to the previous

one, "The Beam and the Bucket" and, as such, it is primarily for people working in the accelerator control rooms.

38689 **(LA-UR—86-1195) Longitudinal emittance measurement at the ATS.** Cottingame, W.B.; Cortez, J.H.; Higgins, W.W.; Sander, O.R.; Sandoval, D.P. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 4p. (CONF-860629—14). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012397.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

With increasing brightness, beam diagnostic techniques requiring interception of the beam become impractical. For H^- particle beams, solutions for this problem based on the phenomenon of photodissociation are now being investigated at the Los Alamos National Laboratory accelerator test stand (ATS). A laser can be used to selectively neutralize portions of the beam than can be characterized after the charged particles have been swept away. We have used this technique for measuring longitudinal emittance at the output of the ATS radio-frequency quadrupole (RFQ).

38690 **(LA-UR—86-1773) Influence of equipartitioning on the emittance of intense charged-particle beams.** Wangler, T.P.; Guy, F.W.; Hofmann, I. (Los Alamos National Lab., NM (USA); Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)). 1986. Contract W-7405-ENG-36. 7p. (CONF-860629—15). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012394.

From Linear accelerator conference; Stanford, CA, USA (2 Jun 1986).

We combine the ideas of kinetic energy equipartitioning and nonlinear field energy to obtain a quantitative description for rms emittance changes induced in intense beams with two degrees of freedom. We derive equations for emittance change in each plane for continuous elliptical beams and axially symmetric bunched beams, with arbitrary initial charge distributions within a constant focusing channel. The complex details of the mechanisms leading to kinetic energy transfer are not necessary to obtain the formulas. The resulting emittance growth equations contain two separate terms: the first describes emittance changes associated with the transfer of energy between the two planes; the second describes emittance growth associated with the transfer of nonlinear field energy into kinetic energy as the charge distribution changes.

38691 **(ORNL/TM—10010) Calculated fraction of an incident current pulse that will be accelerated by an electron linear accelerator and comparisons with experimental data.** Alsmiller, R.G. Jr.; Alsmiller, F.S.; Lewis, T.A. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012591.

In a series of previous papers, calculated results obtained using a one-dimensional ballistic model were presented to aid in the design of a prebuncher for the Oak Ridge Electron Linear Accelerator. As part of this work, a model was developed to provide limits on the fraction of an incident current pulse that would be accelerated by the existing accelerator. In this paper experimental data on this fraction are presented and the validity of the model developed previously is tested by comparing calculated and experimental data. Part of the experimental data is used to fix the physical parameters in the model and then good agreement between the calculated results and the rest of the experimental data is obtained.

38692 **(SLAC-PUB—3927) Some applications of particle-in-cell codes to problems of high intensity beams.** Herrmannsfeldt, W.B. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). Apr 1986. Contract AC03-76SF00515. 9p. (CONF-860520—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011598.

From Conference on charged particle optics; Los Alamos, NM, USA (19 May 1986).

The technique of using the "particle-in-cell" method was developed in the field of plasma physics. Borrowed for problems of intense beams, it becomes an especially powerful tool because such problems frequently use single species "plasmas" and so pose a less severe requirement on the computer. Several problems are examined in which the PIC code method has been useful. The first is the classical Pierce gun in a transient or short pulse mode. Here the transverse beam optics are strongly affected by the time dependence of the current. The second is a study of high power klystrons searching for the source of an instability. The third is the high power rf source called the "lasertron" which is under development at SLAC. The interesting new development for the lasertron simulation is the introduction of a double gap output cavity for improved efficiency. The lasertron and klystron simulations are steady state solutions to rf problems with high-Q cavities. In order to limit the computation to a realistic time, these simulations use an external equivalent circuit which can communicate with the beam tunnel through ports placed at the locations of the rf cavities. Applications for electron beams generally require using a fully relativistic electromagnetic code such as MASK. In some applications, the computation can be speeded up by limiting the solution of the fields to the electrostatic conditions. This can be especially helpful if the degree of precision required demands very large numbers of macroparticles. An example of such an application is shown for a problem involving emittance growth for a high intensity beam for heavy ion fusion.

38693 **(SLAC-PUB—3957) Optics modules for circular accelerator design.** Brown, K.L.; Servranckx, R.V. (Stanford Linear Accelerator Center, Menlo Park, CA (USA); Saskatchewan Univ., Saskatoon (Canada)). May 1986. Contract AC03-76SF00515. 19p. (CONF-860520—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011159.

From Conference on charged particle optics; Los Alamos, NM, USA (19 May 1986).

The first-order differential equations of motion for a single particle in a closed circular machine are solved, introducing the concepts of phase shift, beta functions, and the Courant-Snyder invariant. The transfer matrix between two points in the machine is derived as a function of the phase shift and the parameters contained in the Courant-Snyder invariant. Typical optical modules used in circular machine designs are introduced and related to their characteristic transfer matrix elements, the phase shift through them, and the Courant-Snyder-Twiss parameters. The systematics of some elementary phase ellipse matching problems between optical modules are discussed. Second-order optical modules are discussed, including how they are used to provide the momentum bandwidth needed for the design of a typical circular machine. (LEW)

38694 **Transverse field focused system.** Anderson, O.A. (to Dept. of Energy, Washington, DC). US Patent 4,588,955. 13 May 1986. Filed date 1 Jun 1983. vp.

This patent describes a sheet beam system of charged particles, a transverse field focused system consisting of: pairs of spaced-apart inner and outer electrodes having concentric cylindrical-arc electrode surfaces with entry and exit edges parallel to the axis of curvature of the electrodes and side edges in planes perpendicular to the axis of curvature, the pairs of electrodes being arranged in serial manner with the exit edges of a pair of electrodes being spaced from and generally in line with the entry edges of the next pair of electrodes, means for impressing voltages on the electrodes of each pair thereof to create an electric field between the electrodes to guide the sheet beam of charged particles from the entry edges of the electrodes to the exit edges thereof and along a curved surface between the electrodes, the mean voltage on successive pairs of electrodes being progressively greater, and wherein both side edges of both electrodes of each pair thereof are bent toward the axis of curvature of the electrode surfaces to focus the beam edges.

38695 **Electron trajectories through a linear wiggler calculated with a three dimensional ray tracing program.** Murray,. K.M. (KM Sciences, Arlington, VA 22206). pp 219-226 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

This paper presents a ray tracing program using a realistic representation of the magnetic field produced by a "Halbach" con-

figuration of rare earth cobalt magnets. An analytic expression is derived for the field due to a pair of magnets in each of the two arrangements of the above configuration treating them as being infinitely long in the direction perpendicular to the axis of the wiggler and to the direction of the magnetic field. Empirical expressions are then used to reduce this to the finite length of the magnets. The program was written in BASIC and compiled to run on an IBM PC (TM) equipped with an 8087 math processor.

38696 **PATH - A lumped-element beam-transport simulation program with space charge.** Farrell, J.A. (Los Alamos National Lab., Los Alamos, New Mexico 87545). pp 267-272 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—).

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

PATH is a group of computer programs for simulating charged-particle beam-transport systems. It was developed for evaluating the effects of some aberrations without a time-consuming integration of trajectories through the system. The beam-transport portion of PATH is derived from the well-known program, DECAY TURTLE. PATH contains all features available in DECAY TURTLE (including the input format) plus additional features such as a more flexible random-ray generator, longitudinal phase space, some additional beamline elements, and space-charge routines. One of the programs also provides a simulation of an Alvarez linear accelerator. The programs, originally written for a CDC 7600 computer system, also are available on a VAX-VMS system. All of the programs are interactive with input prompting for ease of use.

38697 **ARCHSIM: A proton synchrotron tracking program including longitudinal space charge.** Thiessen, H.A.; Warren, J.C. (Los Alamos National Lab., Los Alamos, NM 87545). pp 255-260 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—).

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

A particle-tracking program has been written for simulating the acceleration cycle of a rapid-cycling proton synchrotron. A lattice can consist of up to 100 cells and RF cavaties. Transport of the beam in six dimensions includes all second-order optical terms. The RF field and proton velocity are treated exactly. Longitudinal space charge is handled in a self-consistent manner. The fluctuations due to the finite number of particles are handled by a Gaussian smoothing algorithm. The program runs on a VAX 11/780 and can track 100 particles without space charge through the full acceleration cycle from 0.8 to 32 GeV in 49 minutes. A thousand particles with space charge takes about ten hours of computer time.

38698 **Aperture studies of the BNL Colliding Beam Accelerator with reduced superperiodicity.** Dell, G.F. (Brookhaven National Lab., Upton, NY 11973). pp 176-181 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—).

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

Chromatic properties of the Brookhaven CBA (Colliding Beam Accelerator) with one low β insertion in each of the three superperiods have been studied using the PATRICIA particle tracking program. Systematic multipoles of order $5 < n \leq 10$ as well as random multipoles of order $1 \leq n \leq 10$ are, along with random closed orbit errors and sagitta effects, included when determining the aperture of the lattice. The present studies document the expected aperture when the CBA is operated in the low beta mode. To maintain the full aperture, injection at 30 GeV in the standard mode and switching at $\approx$ 100 GeV to the low beta mode is anticipated. Increasing the radial aperture of the first two quadrupoles on each side of the crossing point in the low beta insertion from 40 to 50 mm increases the aperture so that the low beta option could be used at an energy as low as 60 GeV. The expected aperture (solid curve) disagrees with the aperture obtained by tracking in the region $-0.8 < \Delta p/p < 0.0$ percent. This may be an indication that the aperture is limited by the dynamic aperture rather than the physical aperture in this region; this point has not yet been investigated.

38699 **Calculation of polarization effects.** Chao, A.W. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). pp 59-74 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—). Contract AC03-76SF00515.

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

Basically there are two areas of accelerator applications that involve beam polarization. One is the acceleration of a polarized beam (most likely a proton beam) in a synchrotron. Another concerns polarized beams in an electron storage ring. In both areas, numerical techniques have been very useful. This paper discusses the numerical techniques.

38700 **Particle tracking using Lie algebraic methods.** Dragt, A.J.; Douglas, D.R. (Univ. of Maryland, College Park, Maryland 20742). pp 122-127 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—). Contract AC03-76SF00098;AS05-80ER10666.

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

A study of the nonlinear stability of orbits in an accelerator or storage ring lattice usually includes particle tracking simulations. Programs such as PATRICIA typically trace rays through linear and nonlinear lattice elements by numerically evaluating linear matrix or impulsive nonlinear transformations. For large lattices with many nonlinear elements, this can be time consuming because of the necessity of evaluating a separate transformation for each group of linear elements and every individual nonlinear element. Moreover, the validity of the impulsive approximation for nonlinear elements can be questioned. Finally, "linear" elements are really not linear. An alternate approach is to trace rays using the first and second order information about trajectories through beamline elements as provided, for example, by the second order matrix code TRANSPORT. DIMAT works this way. Such an approach has the advantage of being exact through second order. Moreover, it offers the possibility of trying to represent the effect of several elements by a single transfer map thereby increasing the speed of tracking computations. However, because the second order matrix transformations for single elements and collections of elements are in fact generally only correct through second order, they are generally not symplectic (canonical) beyond second order. The errors due to third and higher order violations of the symplectic condition, which condition must hold for Hamiltonian systems, may in some cases build up over long tracking runs, and may, if not properly understood, lead to improper conclusions. It should be emphasized that the failure to be symplectic beyond second order is not due to any error in second order codes. Rather, it is simply a consequence of the fact that the symplectic condition generally requires the retention of terms of arbitrarily high order if it is to be satisfied.

4303 Auxiliaries And Components

REFER ALSO TO CITATION(S) 38697, 38698

38701 (DOE/ER/40048—102-L4, pp 74) **Predicting tandem parameters.** Weitkamp, W.G. Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The author is are developing a program to assist an operator in setting up the tandem accelerator. The program asks a number of questions to determine the ion species and the energy required and the configuration of the machine. It then calculates all beam-optics power supply settings and predicts the beam transmission, using simple algorithms or interpolating between sets of parameters known to give a good accelerator tune. The information is printed out in a form similar to an accelerator log sheet. The program presently works well for beams from the direct extraction ion source and is soon to be completed for beams from the other ion sources.

38702 (LA-UR—86-1987) Status of the Los Alamos heavy ion injector. Riepe, K.B.; Ballard, E.O.; Meyer, E.A.; Wilson, D.C. (Los Alamos National Lab., NM (USA); New Mexico Univ., Albuquerque (USA). Inst. for Accelerator and Plasma Beam Technology). 1986. Contract W-7405-ENG-36. 5p. (CONF-860665—5). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012377.

From 6. international conference on high power particle beams; Kobe, Japan (9 Jun 1986).

Design of practical induction linacs for intense heavy ion beams requires injection of multiple beams from a pulsed electrostatic accelerator at as high a voltage as practicable. Los Alamos National Laboratory is developing a 16-beam, 2 MeV, pulsed electrostatic accelerator for Al^+ ions in cooperation with the multiple beam ion induction linac development program at Lawrence Berkeley Laboratory. The ion source will be a pulsed metal vapor arc plasma. Individual sources will be used for each beam. A biased grid will control plasma flux into the ion extraction region. The beams will be accelerated by a series of electrodes with spacing and shape designed to control beam emittance and divergence. The accelerating column will be made of 85% purity aluminum oxide cylinders brazed to niobium high voltage feedthrough rings. The high voltage pulse will be generated by a 2-MV Marx generator with a special circuit designed to control voltage pulse flatness. The Marx generator and the accelerating column will be cantilevered from opposite ends of the containment vessel, which will be pressurized to 65 psig with a 30/60 mixture of SF_6/N_2. The ceramic column and an 800-kV Marx prototype have been built. The pressure vessel was finished in June 1986. High voltage testing of the column will begin late in 1986.

38703 (LA-UR—86-2214) VUV-soft x-ray beamline for spectroscopy and calibration. Bartlett, R.J.; Trela, W.J.; Southworth, S.H.; Michaud, F.D.; Rothe, R.; Alkire, R.W. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 9p. (CONF-860880—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012432.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

We describe the design and performance of the Los Alamos VUV synchrotron radiation beamline, U3C, on the VUV ring of the National Synchrotron Light Source at Brookhaven National Laboratory. The beamline uses separate function optics to collect and focus the horizontally and vertically diverging beam. The monochromator is a grazing incidence Roland circle instrument of the extended grasshopper design (ERG). A post monochromator refocusing mirror is used to focus or collimate the diverging beam from the monochromator. The beamline control and diagnostics systems are also discussed.

38704 (LBL—21030) Design of 15 mm collars for SSC dipole magnets. Peters, C. (Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098. 21p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012821.

Ten 1-m long dipole magnets of the SSC design "D" cross section have been constructed and tested. In each model a collar type structure was used to contain and support the coil assembly at assembly and during operation at 4K. The collar structure must provide enough coil compression to minimize training and guarantee the coil cross section dimensions. Three types of collar designs were used. The behavior, measured and predicted, of two types of 15 mm stainless steel collars used on eight of the ten models is examined. The mechanical measurement of the 15 mm stainless steel collars used on eight 1-m dipole models are given. Observed behavior and preliminary design criteria are discussed. In order to better understand observed collar behavior and to evaluate new designs, finite element analysis of the collar designs was undertaken, and results are correlated with measured behavior. The behavior of alternate collar designs is predicted. 3 refs., 19 figs. (LEW)

38705 (LBL—21549) Survey of high field superconducting material for accelerator magnets. Scahlan, R.; Greene, A.F.; Suenaga, M. (Lawrence Berkeley Lab., CA (USA); Brookhaven National Lab., Upton, NY (USA)). May 1986. Contract AC03-76SF00098. 6p. (CONF-860583—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012499.

From International Committee for Future Accelerators workshop on superconducting magnets; Upton, NY, USA (12 May 1986).

The high field superconductors which could be used in accelerator dipole magnets are surveyed, ranking these candidates with respect to ease of fabrication and cost as well as superconducting properties. Emphasis is on Nb_3Sn and NbTi. 27 refs., 2 figs. (LEW)

38706 Monitor, the prelude to robotics. Grisham, D.L.; Lambert, J.E. (Los Alamos National Lab., Los Alamos, NM). pp 642-643 of Proceedings of condensed papers of the 7th Miami international conference on alternative energy source. Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1986). (CONF-851201—).

From 7. Miami international conference on alternative energy sources; Miami Beach, FL, USA (9 Dec 1985).

The Monitor system is based on using distance for shielding, electric master-slave servomanipulators and only television for viewing. It consists of these primary components: The slave unit, which is placed at the worksite and consists of a one-ton hydraulic crane that is used to place the electric master-slave servomanipulators at the specific work area. It also has multiple closed-circuit television cameras for proper viewing of the work area. It provides air, hydraulic, and electrical power connections to run the various tools used as well; A control station housed in a trailer that provides a quiet, isolated atmosphere in which to do the tedious, demanding job of remote handling. It provides the masters for the electric master-slave manipulators, hydraulic crane controls, camera controls, tool power controls, as well as numerous television monitors and other operating status indications; A 30-ton radio-controlled building crane for handling objects beyond the capability of the manipulators. This can be and normally is operated from the control trailer to take advantage of the television viewing; The original system developed in 1976 has been expanded to two identical systems capable of working within the main experimental hall at LAMPF. A third system has a portable power generator, thus making it possible to operate in any area that is accessible by truck.

38707 Performing (p,n), (d,n) and (n,n) measurements with a rotating magnet beam swinger. Dietrich, F.S.; Clegg, T.B. (Lawrence Livermore National Laboratory). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 299-301(20 Jan 1985). (CONF-840945—). Contract W-7405-ENG-48.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

Polarized beams of protons and deuterons may be used with a rotating-magnet beam swinger if a spin-precession solenoid is added before the swinger to precess the incoming spin axis.

38708 Lamb-shift sources: hopes and realities. Clegg, T.B. (Department of Physics, University of North Carolina, Chapel Hill, North Carolina 27514). *AIP (American Institute of Physics) Conference Proceedings;* **117**: No. 1, 63-77(25 May 1984). (CONF-830591—).

From Polarized ion workshop; Vancouver, Canada (23 May 1983).

Recent work on Lamb-shift polarized sources which obtain H^- and D^- ions from metastable $H_0(2S)$ or $D_0(2S)$ atoms is reviewed. The new sources completed at Munich and Kyushu during the last two years have improved beam intensities to ~2 μA. Analysis of the factors leading to this improvement is attempted. Two years ago there was hope that electron-cyclotron-resonance sources of H^+ or D^+ could be applied to Lamb-shift sources to yield substantial increases in current. Considerable experimental effort now shows that large increases will be difficult to achieve, although some intensity improvement may still be possible. Laser schemes for polarizing and ionizing the metastable beam are discussed briefly.

38709 **Models and simulations.** Lee, M.J.; Sheppard, J.C.; Sullenberger, M.; Woodley, M.D. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). pp 465-472 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—). Contract AC03-76SF00515.

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

On-line mathematical models have been used successfully for computer controlled operation of SPEAR and PEP. The same model control concept is being implemented for the operation of the LINAC and for the Damping Ring, which will be part of the Stanford Linear Collider (SLC). Errors in construction and modification may cause an actual machine to be different from the ideal machine conceived in the design. When the machine parameter values calculated from the model are substantially different from the measured values, the model cannot be used for computer controlled machine operations such as changing operating configuration or correcting closed orbit errors or trajectory errors. Simulations can be used to develop an empirical model based upon the measured values of beam parameters. The effects produced by suspected errors can be studied by simulating them with a model and comparing the reaults with measured values. In some cases, changes in the model can be found which minimize these differences. This is a possible method for finding an empirical model to represent an actual machine. The authors have used this procedure to find an empirical model for the Damping Ring, which has been in operation for several months. Based upon the measured changes in closed orbits produced by known kicks from orbit correctors, an empirical model has been found which correctly predicts these measured orbit changes. The purpose of this paper is to describe the general relationships between models, simulations and the control system for any machine at SLAC. The work we have done on the development of the empirical model for the Damping Ring is presented as an example.

38710 **High level control programs at NSLS.** Bozoki, E.S. (National Synchrotron Light Source, Brookhaven National Lab., Upton, NY 11973). pp 420-424 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—).

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

The mathematical model of an accelerator can be used to control its operation and also to stimulate its behavior. Through the use of such modeling programs it is possible to control a few important machine parameters rather than the many individual magnets. Such programs have been implemented for the current generation of accelerators. At the NSLS, two control program systems have been developed; TRANCO for the transport lines and RING for the accelerator/storage rings. These systems are modular, can be used independently or in conjunction with each other, can communicate with each other via sequential and random access data files and has a common data base. There are modules for computation, control, display, measurements, data base manipulation, etc.

38711 **Centralized digital control of accelerators.** Melen, R.E. (Stanford Linear Accelerator Center, Stanford Univ., Stanford, CA 94305). pp 289-299 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—). Contract AC03-76SF00515.

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

Upon careful examination of the architecture of SLAC's computer control systems, it becomes evident that the distribution of the systems' intelligence generally falls into tree-like layers. The first layer typically consists of a central computer complex incorporating one or more relatively large and powerful processors. The more modern systems use state-of-the-art 32-bit processors with several megabytes of RAM and several hundreds of megabytes of disk memory. Further, they support extensive user-friendly operating systems and program development facilities. The second layer typically consists of several smaller processors which are downloaded from the central complex and whose primary task is to provide data acquisition and distribution. The more modern systems are 16-bit processors with several hundred kilobytes of RAM and no disk memory. The third layer typically consists of several tens or hundreds of micro-processors, each dedicated to a single device. The micro-processors for these "dedicated intelligent controllers" are small and inexpensive and typically require less than 32 kilobytes of RAM or EPROM memory. Their hardware may be general purpose in nature or may be built into the architecture of the device itself. Figure 5 illustrates several of the relevant features of each of these layers. This paper serves to illustrate that SLAC is commited to the centralized digital control of its accelerators.

38712 **On the problem of magnet ramping.** Bozoki, E.S. (National Synchrotron Light Source, Brookhaven National Lab., Upton, NY 11973). pp 416-419 of Computing in accelerator design and operation. Busse, W.; Zelazny, R. New York, NY; Springer-Verlag New York, Inc. (1984). (CONF-8309144—).

From Europhysics conference on computing in accelerator design and operation; Berlin, F.R. Germany (20 Sep 1983).

In the accelerator rings, the momentum of the beam is being changed. It is necessary to ramp (up or down) all magnets in the ring in perfect synchronism and precisely according to a desired ramping function to prevent beam losses or unwanted changes in the beam characteristics (e.g. tune or chromaticity).

38713 **Sources of low energy, very highly ionized atoms - present status and possible future developments.** Kostroun, V.O. (Cornell Univ., Ithaca, NY). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 303-317(1982). (CONF-820855—).

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

The states of highly charged ions and their interactions with electrons, other ions and atoms are difficult to investigate experimentally at low ion kinetic energies. Investigations in this area have long been hampered by the lack of suitable multiply charged ion sources capable of producing ion beams of a few keV or less kinetic energy and intense enough to permit the type and variety of spectroscopic and collisional experiments available to study neutral or singly charged ions. Over the past decade, a number of sources of multiply charged ions have been developed for nuclear particle accelerators. Two of these, the electron cyclotron resonance ion source (ECRIS) and electron beam ion source (EBIS) show particular promise for use in atomic physics experiments involving low energy, highly ionized atoms. While neither of these sources is ideal, each possesses features which make it suited for a particular class of atomic physics experiments. For example, the EBIS can be used to generate ions of elements throughout the periodic table with the highest extractable charge state of any source, in some case Ar^{+16} and Xe^{+52} have been obtained, while the ECRIS can generate intense beams of highly charged, lower Z elements. In this paper the present status of existing sources of low energy, very highly ionized atoms is reviewed, the potential of these sources for atomic physics experiments is evaluated, and possible future developments in source technology are discussed. 43 references, 4 figures.

4304 Storage Rings

REFER ALSO TO CITATION(S) 38699, 38700, 38709, 38711

38714 **(KFK—3976) Concept for a synchrotron light source with superconducting bending magnets for the production of microstructures by the LIGA-process.** Einfeld, D.; Hagena, O.F.; Henkes, P.R.W.; Klingelhoefer, R.; Krevet, B.; Moser, H.O.; Saxon, G.; Stange, G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Kernverfahrenstechnik). Sep 1985. 60p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752083.

At Karlsruhe the LIGA-process - a combination of lithography using synchrotron radiation with galvanoforming and plastic molding - is being developed. Using this process microstructures of large aspect ratio and great structural height may readily be produced. This paper describes the concept of an electron storage ring

as a synchrotron light source, adapted to the LIGA-process, having a characteristic wave length of 0,23 nm. Its main feature is the use of four superconducting bending magnets excited up to 4 T. Electrons are injected into the storage ring by a 150 MeV racetrack microtron and consequently accelerated by two RF-cavities to 1.4 GeV. The focussing and correction magnets are of standard, normal conducting design. To facilitate a homogeneous irradiation of large areas deflecting dipols are introduced to wobble the stored beam in one of the bending magnets. Three studies for the design of the superconducting bending magnets were ordered from different industrial firms. Two designs proposing C-magnets look particularly attractive since the synchrotron radiation escapes through a slit extending over the whole length of the magnet. Thus radiation not used by lithography may be absorbed by water cooled targets outside the helium cryostat. (orig.).

38715 **Fermilab Accumulator Ring ultrahigh vacuum system.** Mills, F.E.; Bartelson, C.; Gormley, M.; Klen, J.; Lee, G.N.; Marriner, J.; Misek, J.R.; Rathbun, T.D.; Satti, J.A.; Sax, W. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1749-1752(May 1986).

An average pressure of 3 x 10^{-10} Torr is required in order to store a beam of antiprotons (for up to 20 h) in the Fermilab Accumulator Ring. The Accumulator Ring has a circumference of 474 m and consists of 114 main magnets which surround a continuous, stainless-steel vacuum chamber with a mean diameter of 12 cm. The Accumulator Ring is located in a below grade tunnel which is inaccessible during normal operation. Consequently, all monitoring and control operations must be done remotely. In this paper we describe: (1) the rationale of the Accumulator Ring's vacuum system; (2) the specific choice of pumping systems (roughing, ion, and sublimation) that was selected for implementation; (3) the details of the instrumentation, control, and bakeout systems (300 °C) for monitoring the pressure and desorbing the vacuum chamber; and (4) the operating experience and performance of the entire system.

44 INSTRUMENTATION

4401 Radiation Instrumentation

REFER ALSO TO CITATION(S) 38525, 38590, 38598, 38883, 39129, 39208, 39209, 39279

38716 **(CONF-851009—72) Low energy x-ray spectra measured with a mercuric iodide energy dispersive spectrometer in a scanning electron microscope.** Iwanczyk, J.S.; Dabrowski, A.J.; Huth, G.C.; Bradley, J.G.; Conley, J.M.; Albee, A.L. (University of Southern California, Marina Del Rey (USA). Inst. of Physics; Jet Propulsion Lab., Pasadena, CA (USA); California Inst. of Tech., Pasadena (USA)). 1985. Contract AT03-77EV72031. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011963.

From IEEE nuclear science symposium; San Francisco, CA, USA (23 Oct 1985).

A mercuric iodide energy dispersive x-ray spectrometer, with Peltier cooling provided for the detector and input field effect transistor, has been developed and tested in a scanning electron microscope. X-ray spectra were obtained with the 15 keV electron beam. An energy resolution of 225 eV (FWHM) for Mn-K/sub α/ at 5.9 keV and 195 eV (FWHM) for Mg-K line at 1.25 keV has been measured. Overall system noise level was 175 eV (FWHM). The detector system characterization with a carbon target demonstrated good energy sensitivity at low energies and lack of significant spectral artifacts at higher energies. 16 refs., 5 figs.

38717 **(DOE/EV/03522—T4) Biological and clinical dosimetry, July 1, 1964 to December 31, 1984. Final report.** Laughlin, J.S.; Zeitz, L. (Sloan-Kettering Inst. for Cancer Research, New York (USA). Biophysics Lab.). [1986]. Contract AC02-76EV03522. 191p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE86006947.

The goal was to develop systems for the determination of absorbed dose in biological research and clinical applications. The primary method under study is the local absorbed dose calorimeter. In addition, secondary dosimetric systems such as ionization chambers, chemical dosimeters and thermoluminescent dosimeters (TLD) are being developed and applied to provide an absolute basis for the evaluation and comparison of experiments, treatments and other procedures using radiation. In keeping with these objectives this project has accomplished significant advances in the following areas: (1) local absorbed dose calorimetry; (2) neutron dosimetry; (3) dosimetry of ultra-high intensity radiation sources; (4) solid state detector and germanium gamma camera program; (5) dosimetry for brachytherapy; and (6) "non-isolated sensor" calorimeters.

38718 (NBS/SP—711, pp 36-41) **Absolute neutron flux determination: a problem for the measurement of γ/sub n/.** Gilliam, D.M.; Lamaze, G.P. (National Bureau of Standards, Gaithersburg, MD). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

Three different methods of flux monitoring are presented: (1) the activation foil method, (2) the fission chamber method, and (3) two techniques involving ^{10}B. For each method, experimental problems and expected accuracies are discussed. An intercomparison of the techniques is proposed as well as comparisons with other methods. 11 refs., 1 tab.

38719 (NBS/SP—711, pp 112-117) **Long wavelength neutron interferometry.** Zeilinger, A. (Massachusetts Institute of Technology, Cambridge; Atominstitut der Oesterreichischen Universitaeten, Wien, Austria). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

Neutrons in the wavelength range around 20 A have been used for various optical and interferometric experiments. Some of these experiments concerned precision measurements of the diffraction of neutrons at an absorbing edge and at single and double slit assemblies. The results are in perfect agreement with standard linear wave mechanics and place stringent limits on alternative nonlinear variants of the theory. Another experiment concerned the neutron Fizeau effect which demonstrates the relativistic transformation laws for Schroedinger wave functions. Future experiments with 80 to 100 A wavelength neutrons will lead to an improvement over the precision of existing experiments. Also, neutron analogs to the Aharonov-Bohm effects and various time-dependent experiments will become realizable with a very long wavelength neutron interferometer using phase gratings as optical elements. Such gratings are based on the earlier successful tests of Fresnel lenses for very cold neutrons. 21 refs., 4 figs.

38720 (NBS/SP—711, pp 118-123) **Long baseline neutron interferometry.** Deslattes, R.D. Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

Some potential generalizations of crystal diffraction interferometers are considered in regard to technical feasibility and application. Emphasis is placed on large scale systems with characteristic dimensions of the order of 1 meter using laser interferometry to actively stabilize separated diffraction elements. 10 refs., 1 fig.

38721 (NBS/SP—711, pp 124-129) **Effective vibration isolation system for perfect-crystal neutron interferometry.** Arthur, J. (Oak Ridge National Lab., TN). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

Perfect-crystal neutron interferometers are subject to degradation of their performance caused by vibrational accelerations. It is shown that the most seriously offending accelerations are rotational, and an effective and simple vibration isolation system that has been developed at the MIT Neutron Diffraction Laboratory is described. 7 refs., 2 figs.

38722 (NUREG/CR—4553) Field tests of a portable tissue equivalent survey meter for monitoring mixed beta/gamma radiation fields. Martz, D.E.; Rich, B.L.; Johnson, L.O.; Daniel, S.H. III. (EG and G Idaho, Inc., Idaho Falls (USA)). May 1986. Contract AC07-76ID01570. 44p. (EGG—2448). NTIS, PC A03/MF A01 - GPO. File Number TI86013018.

A portable radiation survey meter that provides a tissue equivalent response to photons and beta particles has been designed and field tested. The detector is a very thin plastic scintillator that closely simulates the actual geometry and scattering properties of the relevant skin tissues. The meter reads out the D(0.07) dose rate directly, and indicates the tissue dose rates at other depths with the use of tissue equivalent filters of appropriate thicknesses. Data are presented which compare the D(0.07) and D(10) dose rates recorded by the Tissue Equivalent (TE) survey meter with dose rates recorded by two commercial ion chamber meters for a number of laboratory and field sources. Most commercial ion chamber meters fail to respond adequately to the extreme off-axis beta particles from extended beta sources, and hence require the application of large beta correction factors to change the instrument reading to the true D(0.07) dose rate. The tissue equivalent survey meter exhibits an angular response to beta particles that is very similar to the angular response of an extrapolation chamber. Consequently, there is close agreement between the TE meter and extrapolation chamber readings for a wide variety of beta and mixed beta-gamma rdiation fields. D(0.07), D(3), and D(10) dose rates, measured with the INEL TE meter at a number of typical work stations, are presented.

38723 (PNL-SA—13626) Radionuclide measurements using resonantly enhanced collisional ionization. Whitaker, T.J.; Bushaw, B.A.; Gerke, G.K. (Pacific Northwest Labs., Richland, WA (USA)). Dec 1985. Contract AC06-76RL01830. 10p. (CONF-860146—10). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011618.

From Radiobioassay and internal dosimetry workshop; Albuquerque, NM, USA (20 Jan 1986).

We have begun development of a laser-enhanced collisional ionization method for direct radionuclide measurements, independent of radioactive decay. The technique uses two nitrogen-laser-pumped dye lasers to selectively excite the target isotope to an electronic state near the ionization threshold. The excited actinide atoms then undergo collisions with a buffer gas and are efficiently ionized. The resulting ions can be detected by conventional methods. The attributes of this approach include highly sensitive isotope analysis with relatively inexpensive lasers and a simple vacuum system.

38724 (PNL-SA—13672) Factors involved in the interpretation of beta spectra. Rathbun, L.A. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 16p. (CONF-860149—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011623.

From DOE beta measurement workshop; Albuquerque, NM, USA (23 Jan 1986).

The Beta Measurement Evaluation and Upgrade Program, managed by Pacific Northwest Laboratory (PNL) for the Department of Energy (DOE), has focused on the resolution of the problems associated with the measurement of the beta dose component at DOE facilities. One of the tasks included in this program was the characterization of beta fields at DOE facilities. Beta measurements were made using silicon detectors, scintillation spectrometers, and passive spectrometers. At operating DOE facilities where beta emitters were encountered, measurement was usually complicated by the presence of low-energy photons and the source-to-detector geometry was often hard to define. Backscatter and low-energy beta particles were problems for both calibration and field measurements.

38725 (STRATECH—3-2) Test of a BaF_2 scintillation crystal. Schippers, J.M.; Devries, J. (Technische Hogeschool Delft (Netherlands)). Apr 1983. 15p. (In Dutch). NTIS, PC A02/MF A01.

Gamma energy response and temporal resolution of a BaF_2 crystal were compared with those of a Pilot-U plastic. Using a photomultiplier, the possibility to use the fast ultraviolet component of the gamma ray excited emission spectrum for positron lifetime measurements was investigated. For the gamma energy response, the BaF_2 crystal (height 2.5 cm, diameter 2.5 cm) was coupled to the multiplier with and without an optical coupling compound. In an existing spectrometer, temporal resolution of Pilot-U detectors with 0.5 and 2.5 cm thickness and the BaF_2 crystal was measured. As positron emitters, Na-22, Co-60, Cs-137, Am-241, Co-57, and Bi-2O7 were used. To obtain a temporal resolution comparable to the 0.5 Pilot-U plastic, a 1 mm thick crystal should be used. An improvement is obtained by omitting the (ultraviolet absorbing) coupling compound. For tomographic time of flight purposes, the use of positron emitters with a maximum gamma energy of 300 keV is recommended. 1 reference.

38726 (STRATECH—3-3) Investigation of a drift chamber. Langerveld, D.; Hollander, R.W. (Technische Hogeschool Delft (Netherlands)). Jun 1983. 31p. (In Dutch). NTIS, PC A03/MF A01.

Two double drift chambers built to locate ionizing radiation in one coordinate direction at an accuracy of 1 mm were investigated. For low pressure purposes the investigation was extended with the determination of the spatial resolution at 200 Torr. Disturbances in the time signal, and effects which determine the width of the time spectrum peak were examined. Attention was paid to the energy spectrum of primary electrons at 1 atm and the information yielded. The linear relation between time and position appears to fit accurately. An expression for the electron transport efficiency as a function of the distance to the side-walls is presented.

38727 (UCRL—94098) Slitless, intensified readout, gated spectrometer: wavelength and efficiency calibration, time response characterization. Gerassimenko, M.; Fowler, M.C. (Lawrence Livermore National Lab., CA (USA)). Jun 1986. Contract W-7405-ENG-48. 9p. (CONF-860880—10). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012349.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

A spectrometer has been developed specifically for the x-ray laser effort at Lawrence Livermore National Laboratory (LLNL). The instrument takes advantage of the small divergence and size of the lasing source by positioning all three components - the source, a custom-ruled grating, and a microchannel plate (MCP) detector - on the Rowland circle. The sum of incident and diffracted angles is kept constant. Illuminating a pinhole at the source location with a z-pinch produces wavelength calibration at several energy ranges in the 65- to 200-eV interval. The same source used in conjunction with the MCP camera and Kodak 101 film yields the absolute detector efficiency. Ion bombardment of a beryllium target at the source location produces the X-rays necessary to determine the absolute efficiency of the grating-detector combination at 107 eV. Grating efficiency is then deduced from the MCP efficiency at that energy. Three 25-Ω stripline structures on the MCP allow sub-nanosecond gating of the spectrometer, which improves the signal-to-background ratio. The rise time response of the entire MCP detector-cable assembly is about 200 ps. We also measured the transmission of the filters that are used in suppressing ultraviolet backgrounds.

38728 (UCRL—94116) High intensity line source for x-ray spectrometer calibration. Thoe, R.S. (Lawrence Livermore National Lab., CA (USA)). Jun 1986. Contract W-7405-ENG-48. 8p. (CONF-860880—9). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012351.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

A high intensity electron-impact x-ray source using a one-dimensional Pierce lens has been built for the purpose of calibrating a bent crystal x-ray spectrometer. This source focuses up to 100 mA of 20-keV electrons to a line on a liquid-cooled anode. The line (which can serve as a virtual slit for the spectrometer) measures approximately 800 μ x 2 cm. The source is portable and therefore adaptable to numerous types of spectrometer applications. One particular application, the calibration of a high resolution ($r = 10^4$) time-resolved cyrstal spectrometer, will be discussed in detail.

38729 Germanium detector passivated with hydrogenated amorphous germanium. Hansen, W.L.; Haller, E.E. (to Dept. of Energy, Washington, DC). US Patent 4,589,006. 13 May 1986. Filed date 1 Nov 1984. vp.

An electrical semiconductor device is described having a volume of crystalline germanium semiconductor material of predetermined bulk net impurity concentration and having a passivating layer on a surface of the volume of crystalline germanium semiconductor material wherein the passivating layer is a coating comprised of hydrogenated amorphous germanium. The coating has a composition similar to that which is deposited on the surface by sputtering of germanium in an atmosphere of controlled hydrogen content which atmosphere has a pressure of about 7 micromillimeters of mercury and a hydrogen content selected to be in the range of about 7% to about 17.5%. The passivating layer has a hydrogen content selected to passivate undesirable surface states in the crystalline material of the predetermined bulk net impurity concentration.

38730 Wide-range radiation dose monitor. Kopp, M.K. (to Dept. of Energy, Washington, DC). US Patent 4,588,892. 13 May 1986. Filed date 20 Sep 1984. vp.

A wide-range radiation dose-rate monitor is described including: a proportional counter having an anode and an ionizable gas disposed between the anode and the cathode for sensing ionizing radiation; a current sensing means connected to the anode of the proportional counter for generating an output voltage signal proportional to an input current signal from the anode; a meter connected to the output of the current sensing means and calibrated to indicated measured radiation dose-rate in response to the output signal of the current sensing means; a constant amplitude oscillator for generating an a.c. output at a constant amplitude; means for generating a selected clamping voltage signal at an output thereof; a comparator circuit means responsive to the output voltage signal of the current sensing means and the clamping voltage signal for selectively attenuating the amplitude of the a.c. output signal of the constant amplitude oscillator at an output of the comparator circuit means in response to changes in the amplitude of the output of the current sensing means in excess of the clamping voltage; a step-up transformer having a primary winding and a secondary winding; a power amplifier connected between the output of the comparator circuit means and the primary winding of the transformer; a rectifier/voltage multiplier circuit means connected between the secondary winding of the transformer and the cathode of the proportional counter for generating and applying a high voltage d.c. bias signal to the proportional counter.

38731 Silicon detectors: new challenges. Walton, J.T. (Lawrence Berkeley Lab., CA). *Nuclear Instruments and Methods in Physics Research;* **226**: 1-11(1984). Contract AC03-76SF00098.

An introduction is given to the areas of current interest in silicon radiation detector design and fabrication. Problems associated with detector grade silicon are reviewed. Passivation of detector surfaces with silicon dioxide or amorphous silicon is described. Two examples of silicon detector applications in x-ray detection and x-ray angiography are presented. 24 references, 16 figures.

38732 100 MH/sub z/ fiber optic single transient gamma ray detection system. Ogle, J.W.; Smith, R.C.; Ward, M.; Ramsey, R.; Hollabaugh, J. (Los Alamos National Lab.,.NM). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **500**: 134-140(1984).

From Fiber optics: short haul and long-haul measurements and applications II; San Diego, CA, USA (21-22 Aug 1984).

A fiber optic system has been developed to measure single transient gamma rays. The gamma ray signature is converted to light by the Cerenkov process in a 20 cm length of radiation resistant optical fiber. The signal is transmitted over 1 km of optical fiber and detected by state-of-the-art, 175 MHz analog receivers. The receivers are based on silicon PIN detectors with transimpedance hybrid amplifiers and two stages of power amplification. The dc coupled receivers have less than 2% distortion up to 5 volts with less than 10 mV rms noise and a responsivity of 37,500 V/watt at 800 nm. A calibration system measures relative fiber to fiber transit time delays and system sensitivity. System bandwidth measurements utilized an electron linear accelerator (Linac) with a 50 ps electron pulse as the Cerenkov light source. The system will be described with supporting calibration and characterization data of parts of the system and the whole system. 5 references, 7 figures, 4 tables.

4402 Radiation Effects On Instrument Components, Instruments, Or Electronic Systems

38733 (AD-A—166105/7/XAB) Generation of field-sensitive interface states in commercial CMOS devices. Technical report, 1 September 1983-15 May 1984. Crowley, John L.; Dries, Lawrence J. (Lockheed Missiles and Space Co., Palo Alto, CA (USA)). 31 May 1984. 42p. (LMSC-D—992164). NTIS, PC A03/MF A01.

The introduction of metastable interface states by the application of a voltage stress has been studied in MOS devices from eleven commercial CMOS processes. Field-sensitive interface effects were observed in samples from four out of five Al metal gate processes but only one out of six Si gate processes. A square-root field dependence of the interface state generation was observed. The initial interface-state density was characterized using a low-temperature C-V displacement method and the results correlated to the radiation hardness of the oxides.

38734 (AD-A—166114/9/XAB) Investigation of the basic mechanisms of radiation effects on electronic materials and devices and development of hardening techniques. Volume 1. Technical report, 1 January 1982-1 January 1983. Srour, J.R.; Hartmann, R.A.; Hopkins, M.A. (Northrop Research and Technology Center, Palos Verdes Peninsula, CA (USA)). 1 Dec 1983. 95p. (NRTC—83-25R). NTIS, PC A05/MF A01.

This report presents results of a study of radiation effects on electronic materials and devices. Emphasis is placed on determining the basic mechanisms of the interaction of radiation with these materials and components with a view toward gaining understanding of benefit to developers of radiation-tolerant devices and circuits. Thermally stimulated current measurements were performed on irradiated SiO_2 films in order to obtain basic mechanisms information regarding the nature of hole traps at the SiO_2-Si interface. The same activation energies (approx. 0.85 and approx. 1.3 eV) were observed in both soft and hard oxides. Hard oxides simply have fewer hole traps then their soft counterparts. The effects of sodium contamination were also examined. Time-resolved charge-collection measurements were performed on GaAs devices bombarded with single 5.0-MeV alpha particles. Preliminary data indicate that charge funneling does occur in GaAs. Results of an experimental and analytical study of the effects of 14-MeV neutrons on silicon are presented.

4403 Miscellaneous Instruments

REFER ALSO TO CITATION(S) 37341, 38136, 38156, 38480, 38481, 38484, 38511, 38534, 38664, 39297, 39410, 39423

38735 (CONF-860829—7) Atom probe field ion microscopy. Miller, M.K. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86008532.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

The atom probe field-ion microscope (APFIM) is a very powerful instrument for microstructural and chemical analysis down to the atomic level of a wide range of materials. The principles of the instrument are described.

38736 (CONF-860829—8) APFIM studies of phase transformations. Miller, M.K. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86008533.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

The atom probe field-ion microscope (APFIM) has proven to be a very effective instrument for studying phase transformations in many metallic systems. The atom probe field-ion microscope provides a technique for direct observation and quantification of important microstructural and chemical features of the transformation such as the three-dimensional morphology of the evolving phases, the wavelength and spatial extent of the solute-rich regions, the sharpness of the interface between the phases, and the changes in composition of the coexisting phases. The atomic spatial resolution of the instrument permits the earliest stages of phase transformations to be investigated experimentally. The unrestricted mass range permits the location and quantification of all elements, including the light elements such as carbon and boron, to be determined. In this paper a summary of some of the types of information relating to phase transformations that may be obtained with the atom probe is outlined.

38737 **(ESA-SP—33) Proceedings of the EARSeL/ESA Symposium on European Remote Sensing Opportunities: Systems, Sensors, and Applications.** Longdon, N.; Melita, O. (European Space Agency, 75 - Paris (France)). Jun 1985. 267p. (CONF-8503243—). NTIS, PC A12/MF A01.

From EARSeL/ESA symposium on European remote sensing opportunities: system, sensors, and applications; Strasbourg, France (31 Mar 1985).

Remote sensing platforms and sensors; collection, processing, and dissemination of remotely sensed data in Europe; Spacelab Metric Camera experiments; the Modular Opto-electronic Multispectral Scanner; and remote sensing applications to thematic mapping, pollution monitoring, archaeology, and geology were discussed.

38738 **(LA-UR—86-2084) Fiber optic, Faraday rotation current sensor.** Veeser, L.R.; Day, G.W. (Los Alamos National Lab., NM (USA); National Bureau of Standards, Boulder, CO (USA)). 1986. Contract W-7405-ENG-36. 9p. (CONF-860703—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012413.

From 4. international conference on megagauss magnetic-field generation and related topics; Santa Fe, NM, USA (14 Jul 1986).

At the Second Megagauss Conference in 1979, there were reports of experiments that used the Faraday magneto-optic effect in a glass rod to measure large electric current pulses or magnetic fields. Since then we have seen the development of single-mode optical fibers that can carry polarized light in a closed loop around a current load. A fiber optic Faraday rotation sensor will integrate the flux, instead of sampling it at a discrete point, to get a measurement independent of the current distribution. Early Faraday rotation experiments using optical fibers to measure currents dealt with problems such as fiber birefringence and difficulties in launching light into the tiny fiber cores. We have built on those experiments, working to reduce the effects of shocks and obtaining higher bandwidths, absolute calibration, and computerized recording and data analysis, to develop the Faraday rotation sensors into a routine current diagnostic. For large current pulses we find reduced sensitivity to electromagnetic interference and other backgrounds than for Rogowski loops; often the fiber optic sensors are useful where conductive probes cannot be used at all. In this paper we describe the fiber optic sensors and some practical matters involved in fielding them.

38739 **(LBL—21315) Geometrical relationship between Kikucki line position and excitation error in electron diffraction.** Ling, P.; Gronsky, R. (Advanced Research and Applications Corp., Sunnyvale, CA (USA); Lawrence Berkeley Lab., CA (USA)). May 1986. Contract AC03-76SF00098. 7p. (CONF-860829—30). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012012.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

All of the main features of the geometry of Kikuchi lines can be thoroughly explained using the treatment first proposed by Kikuchi in which the observed diffraction lines are considered to arise from the elastic (Bragg) scattering of electrons that had been previously scattered inelastically by the specimen. The positions of the lines occur at the intersection of Kikuchi cones or Kossel cones with the Ewald sphere, giving an accurate indication of the orientation of the specimen relative to the incident beam direction, and providing a rapid means (inspection) of deducing the sign of the deviation parameter, s. Less obvious from these traditional presentations however is the actual magnitude of s. This paper presents an alternative geometrical construction employing multiple Ewald spheres to illustrate the phenomenon of multiple scattering which is responsible for the formation of Kikuchi lines, and to provide a straightforward derivation of the excitation error from the relative positions of the Kikuchi lines and their corresponding diffraction spots.

38740 **(MSHA/IR—1148) Laboratory and field evaluation of instantaneous reading dust instruments.** Thompson, E.M.; Treaftis, H.N.; Tomb, T.F. (Mine Safety and Health Administration, Arlington, VA (USA)). 1984. 18p. NTIS, PC A02/MF A01. File Number DE86901508.

A study was conducted to evaluate two instantaneous reading dust monitors that utilize the attenuation of beta rays to determine respirable mass dust concentrations. The one monitor utilizes impaction to deposit the sample on a mylar substrate while the other monitor collects the sample on a glass fiber filter. Measurements obtained using test aerosols of coal, limestone, and silica dusts were compared to measurements obtained with the approved personal coal mine dust sampler. Instrument linearity was synthetically checked using mylar and formvar films of varying thickness. The monitor employing the glass fiber filters was also tested in underground coal mines. The results showed that the monitor employing the glass fiber filter overestimated the concentration of all the aerosols tested, while the one using impaction to collect the sample underestimated them in the region 0 to 5 mg/m³. 11 figs., 2 tabs.

38741 **(SAND—86-0921C) Electron microprobe analysis: the upper limit of submicron spectroscopy.** Hlava, P.F.; Chambers, W.F. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 5p. (CONF-860829—18). NTIS, PC A02/MF A01; GPO Dep. File Number DE86009540.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

In the electron microprobe, a beam of high energy electrons is focussed to a fine point on the surface of a fairly thick specimen and the X rays produced are analyzed to determine the chemistry of the "point." The spacial resolution of this instrument for chemical analysis, then, is defined by the volume of material from which the x ray signal originates. This, in turn, is related to factors such as the diameter of the electron beam, the spreading of the electron beam as it penetrates into the sample and interacts with the atoms of the sample to generate X rays, and the extent to which these primary x rays penetrate beyond the region of electron beam interaction and generate secondary x rays by the process of fluorescence. Beam voltage, current, and diameter can all be easily controlled by the analyst. Once the electrons enter the specimen, however, the analyst loses control of their density. Each individual electron follows a unique, erratic path as it passes near, passes through, or collides with parts of the atoms in the specimen. Monte Carlo calculations are a means by which many investigators have tried to model the paths of individual electrons and the interation volume that large numbers of such electrons define. 13 refs.

38742 **Central gas analysis laboratory with remote sampling.** Ellefson, R.E.; Morgan, F.E.; Anderson, B.E. (Monsanto Research Corporation-Mound, Miamisburg, Ohio 45342). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 306-309(May 1986). Contract AC04-76DP00053.

A computerized central analytical facility is described which remotely samples from 70 process points and analyzes the gas samples by mass spectrometry and other analytical techniques. Samples are transported through a capillary by pressure gradient to a vacuum manifold and ultimately to the inlet system of either of two mass spectrometers. Process pressures vary from 400 to 2500 Torr which assures viscous, nonseparative flow within the capillaries, the capillary whose inside diameters range from 0.03 to 0.05 cm. An

exhaust-gas recovery system to retain valuable tritium from samples is also described. The sampling manifold and inlet systems are fabricated from high vacuum components and tubing that is polished on interior surfaces. All valves can be computer controlled or manually operated from a central control console. Valve actuation is verified by process changes. The gas is analyzed by a computer-controlled, magnetic-sector mass spectrometer, the results archived in another computer and the approved results sent to the requestor via a data network.

38743 **Versatile data acquisition system for low-energy electron diffraction.** Anderegg, J.W.; Thiel, P.A. (Iowa State University, Ames Laboratory, Ames, Iowa 50011). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1367-1371(May 1986). Contract W-7405-ENG-82.

We have developed a system for rapid data acquisition from low-energy electron diffraction (LEED) patterns. The essential components of the system are a sensitive silicon intensified target video camera, a commercial video interface, and a PDP 11/23 microcomputer. The system is designed to acquire up to ten diffraction spot intensities and profiles (total) in a short time relative to the time scales of typical surface reactions. The data acquisition system is used in conjunction with standard VarianX four-grid LEED optics in an ultrahigh vacuum chamber. The abilities of the system with respect to versatility, speed, linearity, and signal-to-noise are demonstrated, and data from a study of oxygen chemisorption on Pd(100) are presented.

38744 **Technique for comparing Auger electron spectroscopy signals from different spectrometers using common materials.** Baer, D.R.; Thomas, M.T. (Pacific Northwest Laboratory, Richland, Washington 99352). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1545-1550(May 1986). Contract AC06-76RL01830.

A simple procedure is outlined to obtain relative sensitivity curves that allow data collected on one Auger electron spectrometer to be related to data collected on a different spectrometer or to a standard data set. Data collected on three CMA systems demonstrate that dN/dE peak-to-peak amplitude ratios for pure elements can vary considerably but in a systematic manner for different systems. Such differences can be produced by variations in system design, by specimen or electron gun alignment, spectrometer contamination or other problems. However, if the differences in relative sensitivity are considered in the data analysis, data sets from different systems can be interrelated with reasonable accuracy.

38745 **Oscillations in laser spectroscopic measurements due to fiber transients.** Leonard, D.; Hirschfeld, T. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Applied Spectroscopy;* 40: No. 3, 406-406(Mar 1986). Contract W-7405-ENG-48.

The thermal response of filters required in laser spectroscopy is discussed. Bandpass and neutral density filters produce transiently oscillating beam intensities when expanded to moderatley intense laser beams. It is stressed that careful placement of filters is needed to avoid these oscillating phenomena and the resulting inaccuracies.

38746 **Improvements in detectabilities in polarimeters using high-frequency modulation.** Bobbitt, D.R.; Yeung, E.S. (Department of Chemistry, Ames Laboratory-USDOE, Iowa State University, Ames, Iowa 50011). *Applied Spectroscopy;* 40: No. 3, 407-410(Mar 1986). Contract W-7405-ENG-82.

Improvements in the laser-based polarimeter are described which are dependent on the high-frequency Faraday modulation of the laser radiation. These improvements have resulted in detectabilities approaching the shot noise limit of the system.

38747 **LIDAR techniques for search and rescue.** Cabral, W.L. (Los Alamos National Lab., Los Alamos, NM 87545). pp 560-565 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

Two new approaches to search and rescue using LIDAR techniques are discussed; these topics include laser retroflection and laser-induced fluorescence. These techniques use high-repetition rate lasers at a variety of frequencies to induce either retroflection from plastic corner cubes on life preservers and other emergency markers or fluorescence in dye markers placed in the ocean.

38748 **Physics and design of advanced IR bolometers and photoconductors.** Haller, E.E. (Univ. of California, Berkeley). *Infrared Physics;* 25: No. 1-2, 257-266(1985). Contract AC03-76SF00098.

Spaceborn IR telescopes and other very low photon flux experiments require photoconductors and bolometers with ever increasing sensitivity working at the background limit. Improvements in the understanding of the physics of these devices, advances in semiconductor materials synthesis and device technology, and the introduction of new device concepts such as uniaxially-stressed photoconductors can, in combination, fulfill these new demands. 29 references, 6 figures, 2 tables.

38749 **Fabrication of V-type filaments for surface ionization mass spectrometry.** Stoffels, J.J.; Lagergren, C.R. (Pacific Northwest Lab., Richland, WA). *International Journal of Mass Spectrometry and Ion Processes;* 55: 217-219(1984).

The single V-type filament has been used for decades in surface ionization mass spectrometry. The published technique for fabrication of such filaments consists of folding a flat ribbon of a refractory metal (originally tungsten, but now usually rhenium) in the shape of a V along its length. The ends of the filament are spot-welded together and to supporting posts, resulting in a canoe-shaped trough into which the sample is deposited. This method of fabrication is time-consuming and requires considerable skill to obtain the uniform filament geometry which is essential for consistently efficient production and/or transmission of ions. An alternative fabrication method used in our laboratory is fast, requires little skill, and produces V-type filaments of uniformly good quality. Filament fabrication is accomplished with a special fixture which forms the filament and holds it in position of spot-welding to the support posts of the filament block. The fabrication procedure is described.

38750 **Electronic gravimeter to measure g(r).** Nieto, M.M.; Goldman, T.; Gutschick, V.P. (Los Alamos National Lab., NM). *Geophysics;* 48: No. 1, 39-41(Jan 1983).

The authors point out that a battery may be designed so that in a gravitational field it will have a gravitationally induced emf in addition to an electrochemical one. The gravitationally induced emf of a battery with a small effective electrochemical potential and a long effective length can readily be measured to very high precision by means of any precise voltmeter, and in particular by a Josephson junction. Such a device may be employed to measure any component of the gravitational acceleration vector. It can be constructed compactly enough to be placed down a borehole. Thus, in principle it is an extremely precise and adaptable tool for geophysical exploration. 8 references.

4404 Well Logging Instrumentation

38751 **(N—86-21791) Heat and mass transfer in a dissociated laminar boundary layer of air with consideration of the finite rate of chemical reaction.** Oyegbesan, A.O.; Algermissen, J. (National Aeronautics and Space Administration, Washington, DC (USA)). Feb 1986. Translated from Teplomassoobmen v Dissotsiirovannom Laminarnom Pogranichnom Sloye Vozdukha s Uchetom Konechnoy Skorosti Khimicheskikh Reaktsiy (USSR), v. 2, 126-137. (NASA-TM—78001; CONF-7605177—1). 14p. NTIS, PC A02/MF A01.

From 5. conference on heat and mass transfer; Minsk, Byelorussian SSR (May 1976).

A numerical investigation of heat and mass transfer in a dissociated laminar boundary layer of air on an isothermal flat plate is carried out for different degrees of cooling of the wall. A finite-difference chemical model is used to study elementary reactions in-

volving NO_2 and N_2O. The analysis is based on equations of continuity, momentum, energy, conservation and state for the two-dimensional viscous flow of a reacting multicomponent mixtures. Attention is given to the effects of both catalyticity and noncatalyticity of the wall.

45 EXPLOSIONS AND EXPLOSIVES

4501 Chemical

38752 (LA-UR—86-1975) Design of the Mark 101 magnetic flux compression generator. Fowler, C.M.; Caird, R.S.; Freeman, B.L.; Marsh, S.P. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 8p. (CONF-860703—5). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012380.

From 4. international conference on megagauss magnetic-field generation and related topics; Santa Fe, NM, USA (14 Jul 1986).

The Mark 101 explosive flux compression generator was designed to generate high voltages into external loads. The stators are helically wound but the armature explosive is simultaneously initiated along its axis. Thus, the generator can possess the large inductance of conventional helical generators, but the burntime is substantially reduced. This leads to large generator impedances that lead to high voltage generation. The armature wall-thickness is varied in such a fashion that it leaves the load output aperture open as the armature starts contact with the stator. Calculations are given for a number of designs in which both the number of stator turns and load inductances are varied. It is also noted that flux losses in the generator skin can be significant.

38753 (MLM—3342) Detection of NO_2 from thermally aged PETN by laser induced fluorescence. Dosser, L.R. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 15 Apr 1986. Contract AC04-76DP00053. 7p. NTIS, PC A02/MF A01. File Number DE86012246.

The gaseous decomposition products of PETN were probed with the second harmonic of the Nd:YAG laser at 532 nm. A pulse energy of 2 mJ was used. The bands of the fluorescence spectrum match those of NO_2, thus indicating its presence in the decomposition products. The fluorescence lifetime of NO_2 was observed to be considerably shorter, perhaps as much as two orders of magnitude, than that of pure N_2 gas. This is due to quenching of the fluorescence by the other gases in the fluorescence cell.

38754 (SAND—84-1633) Study of numerical solution methods for two-phase flows. Gross, R.J.; Baer, M.R. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 50p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012265.

A time-splitting numerical technique is developed to solve systems of highly coupled, hyperbolic partial differential equations. The method is illustrated by solving two different model two-phase flow problems. Results obtained by the technique are compared to results obtained from three established numerical methods: upwind differencing, the method of lines and flux-corrected transport, and to known exact solutions. To demonstrate the ability of the time splitting technique in solving a complex two-phase flow with transportive and phase interaction exhibiting greatly disparate timescales, the problem of deflagration-to detonation transition in a granular explosive is solved numerically. The results show that the time-splitting method offers increased accuracy, but that in one dimension the method is 20% to 500% computationally more costly. However, in multidimensional calculations, time-splitting should offer an economy of computer cost and storage. 20 refs., 15 figs., 2 tabs.

38755 (SAND—86-0033) Detonation cellular structure and image processing. Shepherd, J.E.; Tieszen, S.R. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 31p. (CONF-860804—8). NTIS, PC A03/MF A01; GPO Dep. File Number DE86006467.

From 21. international symposium on combustion; Munich, F.R. Germany (3 Aug 1986).

Gaseous detonations universally exhibit an instability that is manifested as cellular patterns on witness plates (sooted foils) or open shutter photographs. The characteristic dimension or cell width λ of the periodic cellular pattern has previously been shown to correlate with failure diameter, critical diffraction aperture dimension and direct initiation energy requirements. Due to the importance of predicting these parameters in assessing detonability hazards, a quantitative method for cell size mesurement is urgently needed. We discuss a technique based on digital image processing of sooted foil records and illustrate the results with data from experiments performed in the Heated Detonation Tube facility at Sandia. We demonstrate that image processing can be used to eliminate some of the uncertainty now present in cell size measurements. The possibility of quantifying cellular irregularity is also explored. 15 refs., 10 figs., 1 tab.

38756 (SAND—86-0162C) Bechgaard salts: spin density wave transitions in a magnetic field. Kwak, J.F. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 7p. (CONF-8606133—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011416.

From International conference on science and technology of synthetic metals; Kyoto, Japan (1 Jun 1986).

Recent magnetotransport results on the field-induced spin density wave state in $(TMTSF)_2PF_6$ under pressure are compared with existing data on $(TMTSF)_2ClO_4$ and with the predictions of current models. The effects observed, particularly the series of phase transitions, are basically the same in both compounds. The observed differences between the two compounds' behaviors can be ascribed to the anion ordering transition which occurs only in $(TMTSF)_2ClO_4$. The data are generally consistent with proposals of field-induced unit dimensionality leading to the FISDW, and with splitting of the Landau levels into subbands under the combined effect of the SDW and magnetic field. 27 refs., 1 fig.

38757 Compression of solid nitromethane to 15 GPa at 298 K. (New Mexico Highlands University, Las Vegas, New Mexico 87701). *Journal of Chemical Physics;* **85**: No. 3, 1534-1538(1 Aug 1986).

The measurement of the isothermal compression of solid nitromethane to 15 GPa at 298 K using high pressure x-ray diffraction techniques is described. The compression data are fit to a model from which bulk moduli are calculated. Most interesting are the linear compression data. The a axis direction, along which the C—N bonds are aligned, shows little increase in repulsion with increasing pressure above 5 GPa. This indicates that the nitro and methyl groups of neighboring molecules may be interacting.

38758 Single-pulse Raman and photoacoustic spectroscopy studies of triaminotrinitrobenzene (TATB) and related compounds. Trott, W.M.; Renlund, A.M.; Jungst, R.G. (Sandia National Laboratories, Albuquerque, NM 87185). pp 368-375 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—). Contract AC04-76DP00789.

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

Pulsed-laser-excited Raman scattering methods and photoacoustic spectroscopy have been applied to the study of porous, granular samples (i.e., pressed pellets) of 1,3,5-trinitrobenzene (TNB), 1-amino-2,4,6-trinitrobenzene (MATB), 1,3-diamino-2,4,6-trinitrobenzene (DATB) and 1,3,5-triamino-2,4,6-trinitrobenzene (TATB). Single-pulse spontaneous Raman spectra have been obtained for all four materials. Using 532-nm excitation, the intensity of the background emission observed with the Raman scattered light varies as TNB > MATB > DATB > TATB. This trend is compared to information on the long-wavelength absorption edge of MATB, DATB and TATB as determined by the photoacoustic spectra of these materials. Stimulated Raman scattering has been observed for three of the compounds with conversion efficiency as follows: DATB > TATB > MATB. In the case of TATB, this process may be limited by photo-induced chemical reactions. The relatively efficient formation of one or more stable photolysis products in TATB is evident on the basis of its photoacoustic spectrum.

Preliminary single-pulse Raman scattering measurements on shocked TATB are also described.

38759 **Volumes and sound speeds of two gun propellants at high pressure.** Costantino, M. (Lawrence Livermore National Lab., CA). *Propellants, Explosives, Pyrotechnics;* 9: 22-29(1984). Contract W-7405-ENG-48.

Gun propellants are subjected to a variety of high stress states during the ballistic cycle. Attempts by constitutive modelers to describe the response of the propellant during the cycle are hampered by an almost complete lack of well-characterized experimental data at high pressures. The authors present quasistatic, hydrostatic pressure-volume, and compression and shear-wave-speed data on two formulations of a low porosity propellant. The hydrostat shows three distinct regions at pressures to 200 MPa. Below about 60 MPa, the response is elastic, with an effective compressibility controlled by the porosity; from ~ 60 MPa to 140 MPa the porous matrix fails and the material softens as the porosity distribution is crushed; above ~ 140 MPa, the bulk modulus continues to increase to the value for the matrix. Both the hydrostat and sound speed data show significant time-dependent effects with characteristic times of ~ 10^3 s and > 10^4 s. 16 references, 9 figures, 5 tables.

4502 Nuclear

REFER ALSO TO CITATION(S) 38733, 38734, 38940, 39008, 39432, 39433, 39434

38760 **(AD-A—165794/9/XAB) Soviet exploitation of the nuclear winter hypothesis. Technical report, 8 May 1984-4 June 1985.** (Science Applications International Corp., McLean, VA (USA)). 5 Jun 1985. 80p. (SAIC—84/1310). NTIS, PC A05/MF A01.

This study, which is based entirely on open Soviet sources, examines and analyzes Soviet views on and uses made by Soviet scientists of the so-called Nuclear Winter hypothesis. In particular, the study seeks to ascertain whether Soviet scientists have in fact independently confirmed the TTAPS prediction of a Nuclear Winter phenomenon or have contributed independent data or scenarios to it. The findings of the study are that the Soviets view the Nuclear Winter hypothesis as a political and propaganda opportunity to influence Western scientific and public opinion and to restrain U.S. defense programs. Analysis of Soviet publications shows that, in fact, Soviet scientists have made no independent or new contributions to the study of the Nuclear Winter phenomenon, but have uncritically made use of the worst-case scenarios, parameters, and values published in the Crutzen-Birks (Ambio 1982) and the TTAPS (Science, December 1983) studies, as well as models of atmospheric circulation borrowed from Western sources. Furthermore, current Soviet directives to scientists call for work on the further strengthening of the Soviet Union's military might, while it is also explained that the dire predictions of the possible consequences of a nuclear war in no way diminish the utility of the Soviet civil defense program and the need for its further improvement.

38761 **(AD-A—166163/6/XAB) West European and East Asian perspectives on defense, deterrence, and strategy. Volume 2. Western European perspectives on defense, deterrence, and strategy. Technical report, 1 December 1982-15 May 1984.** Pfaltzgraff, R.L.; Davis, J.K.; Dougherty, J.E.; Perry, C.M. (Institute for Foreign Policy Analysis, Inc., Cambridge, MA (USA)). 16 May 1984. 236p. NTIS, PC A11/MF A01.

A survey of contemporary West European perspectives on defense, deterrence, and strategy, with special emphasis on the role of nuclear weapons deployed in, or assigned to, the NATO area. Changes have occurred during the past decade in the relative military strength of NATO and the Warsaw Pact, particularly as a result of the substantial growth in Soviet nuclear-capable systems and conventional forces assigned to Europe, and the momentum manifested by the Soviet Union in its deployments of intercontinental ballistic missiles. There has also been a substantial shift in West European thinking and attitudes about security and strategy. Together, these trends have created a need to reassess the posture of NATO forces generally, and especially nuclear weapons, both in a broader Euro-strategic framework and on the Central Front in the 1980s. The survey is on such issues as the future of the British and French national strategic nuclear forces; the role of the U.S.-strategic nuclear forces in the deterrence of conflict in Europe; the prospects of raising the nuclear threshold by the deployment of new conventional technologies; the impact of strategic defense initiatives on U.S.-NATO security; and the modernization of NATO intermediate-range nuclear capabilities, especially in light of the continuing deployment of the Soviet Union of new generation Euro-strategic forces targeted against Western Europe.

38762 **(AD-A—166280/8/XAB) Nuclear-weapon-effect research at PSR (Pacific-Sierra Research Corporation) - 1983. Volume 10. Symptomatology of acute radiation effects in humans after exposure to doses of 75 to 4500 rads (cGy) free-in-air. Final technical report, 27 October 1982-30 November 1983.** Baum, S.J.; Young, R.W.; Anno, G.H.; Withers, H.R. (Pacific-Sierra Research Corp., Los Angeles, CA (USA)). 31 Aug 1984. 67p. (PSR—1422-VOL-10). NTIS, PC A04/MF A01.

This report distills from available data descriptions of typical human symptoms in reaction to prompt ionizing radiation in the dose range 75 to 4500 rads (cGy) free-in-air. The descriptions correlate symptoms with dose and time over the acute post-exposure period of six weeks. Their purpose is to provide an empirical base for estimating combat troop performance after a nuclear weapon attack. The dose range of interest is subdivided into eight subranges associated with important pathophysiological events. For each subrange, the signs and symptoms manifested by an exposed population are estimated--symptom onset, severity, duration, and incidence. The early or prodromal phase of radiation sickness begins about 2 to 4 hrs after doses of 300 to 530 rads (cGy). Onset time diminishes with dose, occurring within minutes of exposure to 4500 rads (cGy). Characteristic prodromal symptoms are nausea, vomiting, anorexia, and diarrhea. The prodromal phase lasts from several days to a matter of hours, depending on dose. Symptoms of the hemopoietic syndrome are bleeding, fever, infection, and ulceration. Symptoms of the gastrointestinal syndrome are fluid loss, electrolyte imbalance, severe diarrhea, and septicemia.

38763 **(AD-A—166282/4/XAB) Nuclear-weapon-effect research at PSR (Pacific-Sierra Research Corporation) - 1983. Volume 9. Acute radiation effects on individual crew member performance. Final technical report, 26 October 1982-30 November 1983.** Anno, G.H.; Wilson, D.B.; Dore, M.A. (Pacific-Sierra Research Corp., Los Angeles, CA (USA)). 31 Aug 1984. 478p. (PSR—1422-VOL-9). NTIS, PC A21/MF A01.

Quantitative estimates are developed of performance levels of selected U.S. Army combat crew members exposed to prompt ionizing radiation from nuclear weapons. The performance levels, expressed as percentages of normal (baseline) task performance, provide information for military operational planning, combat training, and computer-simulation modeling of combat-crew and unit effectiveness. A methodology is described using data from two separate bodies of information; (1) acute radiation sickness symptomatology, and (2) judgment of typical task performance time as recorded on army combat-crew questionnaires. Those bodies of information are integrated to compute performance level as a function of dose (free-in-air) and postexposure time. Using radiation effects and symptomatology descriptions for each of eight separate dose ranges covering exposures from 75 to 4500 rads (cGy), a structure of symptom complexes is formed in the dose/time domain extending 6 weeks after exposure to prompt radiation. Descriptions of symptom complexes used in the Army combat-crew questionnaires form the link between dose/time and the task-performance estimates provided by supervisors of combat crews. The study focuses on soldiers representing four different crews, from the artillery (both gun and fire direction center crews), armor, and antiarmor, because their operations include the prospect of decisive encounters where one of the combatant crews will probably be put out of action.

38764 (AD-A—995249/0/XAB) Operation Sandstone. Nuclear explosions. 1948. Scientific Director's report of atomic weapon tests at Eniwetok, 1948. Annex 5, Part 1. Blast measurements summary report. Aronson, C.J.; Hartmann, G.K.; Lampson, C.W.; Wood, C.H. (Joint Task Force Seven, Washington, DC (USA)). 16 Jun 1948. 193p. NTIS, PC A09/MF A01.

This report summarizes all activities of the Blast Measurements Section of Task Group 7.1, Operation Sandstone. A brief discussion is included on the general reasons for the choice of instruments which was made at the beginning of the operation. There follows a description of the actual locations of instruments. The remainder of the report is devoted to various theoretical treatments which have arisen in connection with the work. The standard comparison curve for pressure versus reduced distance is derived; some new results on the positive pressure-time curve for a spherical blast wave, the positive duration, and the impulse-time and impulse-distance variations for spherical blast waves are presented. Energy transport in the blast wave is discussed.

38765 (AD-A—995260/7/XAB) Worldwide fallout from Operation Castle. List, R.J. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Aug 1984. 223p. NTIS, PC A10/MF A01.

A worldwide network of gummed-film stations was established to monitor fallout following Operation Castle. Although meteorological data were poor, a general connection of tropospheric flow patterns with observed fallout was evident. There was a tendency for debris to remain in tropical latitudes, with incursions into the temperate regions associated with meterological disturbances of the predominately zonal flow. As the season advanced, such incursions became more evident. Outside of the tropics, the southwestern United States received the greatest total fallout, about five times that received in Japan. The total world-wide fallout up to July 1, 1954, from the Castle series outside of the immediate test areas, is estimated to be about (censored) of the total fission activity produced. The maximum fallout on any day at an individual station in the United States, corrected to sampling day, was 200,000 d/m/sq. ft. It is concluded that the probability of early fallout in inhabited regions would be reduced by holding Pacific test series in the winter months.

38766 (AD-A—995261/5/XAB) Operation Sun Beam - Shot Little Feller I. Project Officers report - Project 8.1. High-time resolution of the first thermal pulse. Bluford, B.L.; Godwin, R.; Benson, R.; Metler, W.; Caruba, W. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 44p. NTIS, PC A03/MF A01.

The primary objective of the measurements program was to obtain the general shape of the first pulse in four wavelength regions designated as ultraviolet, visible, near-infrared, and broadband. A secondary objective was to determine the ratio of direct-to-scattered radiation for the first pulse in the same-wavelengths regions. Procedure was to attenuate and spectrally limit incoming radiation to various photodetectors whose electrical outputs were amplified and recorded on oscilloscope cameras and sometimes on magnetic tape. The general shape of the first pulse of thermal radiation from the Little Feller I event was measured in three wavelength regions. Instrumentation for measuring the ratio of direct-to-scattered radiation was saturated and no data were obtained. This is an NTPR(Nuclear Test Personnel Review) report.

38767 (AD-A—995262/3/XAB) Operation Hardtack. Project 1.4. Physical characteristics of craters from near-surface nuclear detonations. Report for April-October 1958. Patteson, A.W. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 41p. NTIS, PC A03/MF A01.

The objective of this project was to measure and correlate with existing data the physical characteristics of craters (radius, depth, lip height and width, throwout, and permanent vertical ground-surface displacement surrounding the crater) resulting from near-surface nuclear detonations.

38768 (AD-A—995263/1/XAB) Operation Hardtack. Project 1.9. Loading on buried simulated structures in high-overpressure regions. Report for April-October 1958. Bultmann, E.H.; McDonough, G.F.; Sinnamon, G.K. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 60p. NTIS, PC A04/MF A01.

The objective of this project was to study some of the factors affecting the transmission of air-blast-induced pressure through soil and the loading produced on buried structures by such pressures in the high-pressure region (approximately 250 psi). Factors studied were: (1) the attenuation of pressure in a sand deposit when the water table is a few feet below the ground surface; (2) the effect of duration of positive phase of blast on the pressure transmitted through such a soil; (3) the effect of structure flexibility on the pressure acting on structures buried in such a soil; and (4) the relationship between horizontal and vertical pressures in such a soil. The project employed 43 devices, each a rigid cylinder having one rigid end and one deformable-diaphragm end. The devices were buried at depths ranging from 0 to 20 feet at each of two locations at the Eniwetok Proving Ground. The locations were chosen to give a predicted ground surface overpressure of about 250 psi from each of two shots, Cactus and Koa.

38769 (AD-A—995264/9/XAB) Operation Hardtack. Project 1.5. Refraction of shock from a deep-water burst. Report for April-October 1958. Burbank, C.J.; McMillian, T.; Johnson, C.T.; Rusconi, J.E. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 21p. NTIS, PC A02/MF A01.

The objectives were to check the validity of the theory of refraction of shock waves by determining the effect of refraction (resulting from temperature, salinity, and pressure gradients) on peak pressures and on wave shapes and to obtain free-field underwater-pressure records as a function of distance, depth, and time for support of other projects. Gages were installed in five different stations located at 2036, 4421, 7702, 9189, and 10.420 feet on a radial line from surface zero. The importance of shock-wave refraction was substantiated at the 9189-foot station by the magnitudes of the pulses, which were significantly lower than would be predicted by calculations using isovelocity conditions.

38770 (AD-A—995265/6/XAB) Operation Hardtack. Project 1.6. Water-wave measurements. Report for April-October 1958. Kidd, L.W.; Johnson, R.H. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 64p. NTIS, PC A04/MF A01.

The objectives were to study wave-generation mechanisms for two underwater shots, Wahoo and Umbrella, and to examine the terminal effects of these waves by inundation studies. These studies were to be integrated with the results of previous nuclear explosions under related geometries to the end that rational prediction might be made of the water waves resulting from future nuclear explosions. Inundation from Wahoo was much greater than anticipated. Inundation from Umbrella was negligible because of the protection afforded the inlands by an extensive lagoon reef.

38771 (AD-A—995266/4/XAB) Operation Crossroads. Report of the Technical Director. Volume 2. Enclosures L thru R. Wyckoff, C.W.; Shaftan, K.; Penney, W.G.; Von Neumann, J.; Debenham, J.K. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Aug 1984. 401p. NTIS, PC A18/MF A01.

These enclosures contain: L--detailed photographic plans for Shot Baker along with a preliminary interpretation of the results; M--additional information on the technical photography for Operation Crossroads; N--instrumentation plan and organization for Crossroads; and R--a set of calculated data for primary and reflected shocks. Enclosures O, P, and Q are omitted since they include plans for Test C which was not executed.

38772 (AD-A—995267/2/XAB) Operation Ivy. Report of commander, Task Group 132.1. Pacific Proving Grounds. Joint Task Force 132. Burriss, S.W. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 58p. NTIS, PC A04/MF A01.

The mission of the Task Group included the responsibilities to conduct experimental measurement programs on Shots Mike and King and to conduct the radiological safety program. Programs were established to make radiochemical analysis of bomb debris; to follow the progress of the nuclear reaction; to make neutron, gamma-ray, blast, thermal radiation, and electromagnetic measurements; and to make a preliminary geophysical and marine survey of the test area. The organizational structure and command relations to accomplish the mission are outlined.

38773 **(AD-A—995269/8/XAB) Operation Argus. Sounding rocket measurements - Project Jason.** Beavers, J.L.; Allen, L.; Dennis, J.L.; Welch, J.A.; Walton, R.B. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Aug 1984. 81p. NTIS, PC A05/MF A01.

The general objective was to measure the distribution of beta particles originating from the Argus shots and subsequently trapped in the earth's magnetic field. This was accomplished with the aid of high-altitude sounding rockets containing radiation counters. The flux of high-energy electrons was measured as a function of: (1) magnetic latitude from 23 to 39 degrees; (2) altitude from sea level to 900 km; (3) electron energy; (4) time after the nuclear explosion; and (5) angular distribution with respect to magnetic field.

38774 **(AD-A—995270/6/XAB) Operation Argus. Surface measurements - project midas.** Newman, P.; Chernosky, E.; Markham, T.; McCabe, L.; Peterson, A. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Aug 1984. 77p. NTIS, PC A05/MF A01.

The objective was to make surface measurements of the electromagnetic and optical effects in the detonation area (South Atlantic) and in the area geomagnetically conjugate (Azores) during the Argus experiment. The project participated in three events - Argus I, II, and III.

38775 **(AD-A—995271/4/XAB) Operation Castle. Project 7.1. Electromagnetic radiation calibration, Pacific {roving ground. Report for March-May 1954.** Olseon, M.H. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Aug 1984. 34p. NTIS, PC A03/MF A01.

A total of 17 stations, one close-in (320 km from Bikini and 23 km from Eniwetok) and the balance at distances, were operated for the electromagnetic experimental effort. Seventy-four sets of data were obtained from a possible total of 102. Of the remaining 28 sets, no data were obtained because equipment was not in operation, records were not readable, the alert notifications were not received, signals were not discernible, or equipment malfunctioned.

38776 **(AD-A—995272/2/XAB) Operation Castle. Operation Plan Number 1-53. Task Group 7.1.** Ogle, W.E. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Aug 1984. 133p. NTIS, PC A07/MF A01.

Overseas experimentation depends upon progress of construction, reliability of instrumentation and the overcoming of obstacles presented by local conditions. This Operation Plan is intended to be used as a guide for TG 7.1 personnel since it represents a record of agreements arrived at prior to its compilation.

38777 **(AD-A—995273/0/XAB) Operation Upshot-Knothole. Project 29.1. Comparison and evaluation of dosimetry methods applicable to gamma radiation, Nevada Proving Ground. Report for March-June 1953.** Taplin, G.V.; Sigoloff, S.C.; Douglas, C.H.; Paglia, D.E.; Heller, C.J. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 68p. NTIS, PC A04/MF A01.

The three major objectives and parts of this project were to compare and evaluate the accuracy and practicality of chemical vs film and other methods of gamma dosimetry for radiations encountered under bomb conditions at sites receiving (1) either prompt- or residual-gamma exposures or mixtures of both, (2) only residual-gamma radiations, either neutron induced or from fission-product fallout, and (3) mixed neutron-gamma irradiation plus correlation with biological effects.

38778 **(AD-A—995274/8/XAB) Operation Jangle Project 2.0 - predicted scaling of radiological effects to operational weapons Report for October-November 1951.** Schorr, M.G.; Gilfillan, E.S. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 119p. NTIS, PC A06/MF A01.

This report predicts the radiological contamination that may result from fission bombs detonated near the surface of the earth and underground. The radiation received is primarily a result of the initial radiation from the early fission products and fallout of radioactive material from the high cloud. The distribution of the fallout is determined by constructing a mathematical model and adjusting the parameters of the model to fit actual Jangle data. The model is then scaled up to larger weapons by scaling these parameters in conformity with existing formulations of nuclear-explosion cloud dynamics. The initial radiation is calculated in a straightforward manner. The resulting dose and dose-rate contours are given, as are the areas enclosed by given contours. It is concluded that the base surge at the Jangle underground nuclear explosion did not contain an appreciable amount of radioactive material, and this will probably also be true for operational weapons except at very great explosion depths. The cratering action of explosives is discussed, and it is found that atomic bombs exploded near the earth surface should give crater radii which sale as the one-sixth power of the energy release rather than the one-third power scaling applicable to high explosives.

38779 **(AD-A—995277/1/XAB) Operation Greenhouse. Scientific Director's Report. Annex 1.12. Long-distance measurement of energy yield of an atomic explosion. Nuclear explosions 1951.** Hudgins, A.J. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 47p. NTIS, PC A03/MF A01.

The energy yield of an atomic explosion was determined at logn distance by measuring the time variation of the light from the explosion and applying an empirical formula that relates this to the energy yield. The light was detected by an RCA 5819 photomultiplier tube and was recorded on a magnetic-tape recorder. Measurements at Shot Easy were made from A C-54 airplane flying at 12,500 ft at a distance of 630 miles northwest of Eniwetok. The time to the minimum of light intensity was 23.5 + or - 0.8 msec, corresponding to a yield of 53 + or - 4 kt. The yield calculated from the radiochemical measurements was 46.8 + or - 1.0 kt. The peak intensity of the flash above the ambient was measured to be 1.7 millicandles/sq ft. This experiment indicated that energy yield can be measured at a distance greater than 630 miles at night. Possible propagation mechanisms are discussed. Studies of the maximum range in daylight and of improvements in technique are suggested.

38780 **(AD-A—995279/7/XAB) Operation Ivy. Pacific Proving Grounds. Projects 2.1 to 2.4 and Project 2.6, measurements of reaction history. Volume 1. Summary of results. Final report.** Drause, E.H. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 19p. NTIS, PC A02/MF A01.

This is the final report on the Naval Research Lab diagnostic experiments performed on Operation Ivy during the fall of 1952.

38781 **(AD-A—995280/5/XAB) Operation Plumbbob. Program 2. Neutron and gamma radiation from Shot Laplace.** Chiment, J.A.; Goetz, J.L.; Facer, G.C. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 40p. NTIS, PC A03/MF A01.

The objectives of this experiment were to determine, for Shot Laplace, a 1.22-kt device fired late in Operation Plumbbob: (1) intensity and decay of the neuron-induced gammafield; (2) neutron flux and spectra as a function of distance; (3) neutron flux as a function of soil depth with certain selected detectors; and (4) neutron dose and initial gamma dose as a function of distance.

38782 **(AD-A—995281/3/XAB) Operation Hardtack. Projects 8.7/2.12d. Thermal radiation from very-low-yield burts, April-October 1958.** Mahoney, J.J.; Maloney, J.C.; Furrow, S.D.; Kilminster, D.T.; Alvares, N.J. (Kaman Tempo, Santa Barbara, CA (USA)). 31 Oct 1984. 27p. NTIS, PC A03/MF A01.

THe objectives of Project 8.7 were to determine the thermal radiant exposure (cal/sq cm) versus distance from ground zero for

a fractional-kiloton nuclear device and the total luminous flux (lumens/sq ft) as a function of both time and distance from ground zero. The objectives of Project 2.12d at shot Hamilton were to determine the thermal radiant exposure versus distance for a fractional-kiloton detonation, and to compare the experimentally obtained radiant-exposure values with those calculated from existing scaling laws.

38783 (UCRL—94252) Beta decay of neutron-rich transuranic nuclei. Hoff, R.W. (Lawrence Livermore National Lab., CA (USA)). 6 Jun 1986. Contract W-7405-ENG-48. 8p. (CONF-860741—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011882.

From International symposium on weak and electromagnetic interactions in nuclei; Heidelberg, F.R. Germany (1 Jul 1986).

Allowance is made for beta-delayed fission in the calculation of the mass yield of underground thermonuclear explosions. This allowance is made by calculating a correction factor by four different methods. These correction factors are applied to a simple model of product yield and the accuracy and potential usefulness of the results are discussed. 19 refs., 3 figs., 1 tab. (DWL)

4503 Explosion Detection

38784 (AD-A—166155/2/XAB) Measurement of elastic properties and static strength. Final report, 1 July 1983-1 October 1984. Johnson, T.L. (Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory). 1 Oct 1984. 52p. NTIS, PC A04/MF A01.

Prediction of seismic coupling for nuclear monitoring requires theoretical models capable of calculating ground motions. The models must have a sound physical basis and be able to represent dynamic material behavior near the source. This portion of the study of stress-wave propagation in low-porosity rock is aimed at determining quasi-static properties of rock necessary to use in numerical models predicting wave propagation. Further, the failure process of low-porosity rock under simulated shock loading is being studied to establish the failure mechanisms. Initial effort supported by the contract was devoted mainly to obtaining and preparing samples of Westerly granite for experiments. Preliminary experiments to characterize the properties of Westerly granite were performed on small samples obtained from the Bonner Monument Co. Material properties measured agreed well with previous determinations. Deformation of Westerly Granite was measured under standard triaxial loading conditions and under a loading path mimiking shock-wave passage. Unlike high-porosity rocks, the different loading paths did not substantially affect the strength of the low-porosity granite. The failure envelope determined in standard triaxial tests agreed well with that measured under simulated shock loading.

50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC

38785 (AD-A—165923/4/XAB) Defense Nuclear Agency Reaction Rate Handbook. Second Edition. Revision Number 9. Report for 1 March-1 June 1983. Baurer, T.; Bortner, M.H. (Utah Univ., Salt Lake City (USA). Dept. of Computer Science). 9 Jun 1983. 203p. NTIS, PC A10/MF A01.

The 26 chapters of this handbook are concerned with atmospheric and ionospheric physical and chemical processes under both natural and disturbed conditions and the effects of disturbances on electromagnetic transmission. Topics covered are the structure, fluid mechanics and aeronomy, and ionospheric energy balance of the natural atmosphere; chemical kinetics of the naturally and nuclear-perturbed atmosphere; data-gathering methods based on laboratory experimentation, theoretical analysis, and atmospheric measurements; basic energy-level and equilibrium data; infrared kinetics of atmospheric radiative processes; cross-section data, solar photoionization rate constants, ultraviolet intensities, and solar dissociation of photochemical processes; low-energy electron and high-energy heavy-particle collision kinetics; charged-particle recombination processes; electron attachment-detachment processes; thermal and nonthermal ion-neutral reactions; excitation-deexcitation processes; radiofrequency absorption; and computer modeling of deionization processes. Each chapter contains numerous references.

5001 Basic Studies

38786 (DP—1701-3) Proceedings of the DOE/AMS air pollution model evaluation workshop. Volume 3. Summary, conclusions, and recommendations. Kurzeja, R.J.; Weber, A.H. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Dec 1985. Contract AC09-76SR00001. 27p. (CONF-8410165—Vol.3). NTIS, PC A03/MF A01; GPO Dep. File Number DE86011668.

From DOE/AMS air pollution model evaluation workshop; Charleston, SC, USA (23 Oct 1984).

This is Volume 3 of the Proceedings of the Kiawah Workshop. Presented are summaries of Volume 1 (Papers Presented) and Volume 2 (Statistical Analysis of Results). Also presented are a discussion of the major issues raised at the workshop and recommendations for future research on dispersion models. Important issues discussed at the workshop included the factors contributing to uncertainty in dispersion modeling, model evaluation for research and regulation, and ways to improve models. Recommendations included the following: model evaluation should consist of exploratory data analysis to determine unusual properties, followed by the determination of uncertainties. It is desirable for a regulatory agency to establish a performance data base by evaluating many models with the same data base. It was also recommended that more attention be given to determination of three-dimensional wind fields as the best way to improve model performance.

38787 (SAND—85-1053) Meteorological tower data, Yucca Ridge (YR) site, January-June 1983. Nevada Nuclear Waste Storage Investigations Project. Church, H.W.; Freeman, D.L.; Boro, K.; Egami, R.T. (Sandia National Labs., Albuquerque, NM (USA); Nevada Univ., Reno (USA). Desert Research Inst.). Jun 1986. Contract AC04-76DP00789. 50p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012732.

The purpose of the NNWSI meteorological data collection program is to support environmental evaluations of site suitability for a nuclear waste repository. This is the first in a series of data summaries for the Yucca Ridge Site in southern Nevada and covers the 6-month period of January to June, 1983.

38788 Physical phenomena induced by microwave pulse propagation in the atmosphere. Yee, J.H.; Maynall, D.J.; Alvarez, R.A.; Sieger, G. (Lawrence Livermore National Lab., Livermore, CA). pp 4B-8 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract W-7405-ENG-48.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The authors have developed a computer code to investigate the dynamic behavior of short microwave pulses propagating through the atmosphere. Using the code, they have calculated the effect of the nonlinear avalanche ionization process in absorbing the energy of pulses of different shapes and frequencies as they propagate through the atmosphere. The calculations are based on solutions to Maxwell's equations and to the relativistic electron fluid equations. This set of equations is different than the set of fluid equations used in previous work. The theoretical results show that, as the initial energy of the microwave pulses increases, the altitude where breakdown begins to occur shift downward. Thus, the higher the pulse intensity, the lower the altitude of breakdown. The electron density created through the nonliinear avalanche ionization process reaches a critical density for high pulse intensity. As a result, the microwave suffers not only erosion at the tail, but also suffers reflection and dispersion as well. The energy that transmits through the atmosphere has also been calculated as a function of frequency for different pulse widths. The results show that, as the frequency increases, the energy also increases. The pulse distortion induced by relativistic effects was also investigated. The physical explanation of this phenomenon will be presented. In addition, they present results of calculations concerning the effect of oxygen and water absorption on the propagation of short microwave pulses.

5002 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 37311, 37312, 37316, 37331, 37366, 37470, 38110, 38214, 38224, 38225, 38290, 38503, 38531, 38666, 38857, 38861, 38868, 38877, 38881, 38903

38789 (AD-A—165878/0/XAB) Diffusion Estimates Handbook (application to the Space Shuttle HC1 exhaust cloud). Report for October 1985-February 1986. Schacher, G.E.; Larsen, S.; Mikkelsen, T. (Naval Postgraduate School, Monterey, CA (USA)). Feb 1986. 44p. (NPS—61-86-009). NTIS, PC A03/MF A01.

A simplified method is presented for making atmospheric diffusion estimates. The method is applied to the Space Shuttle HCl exhaust hazard at Vandenberg Air Force Base. A set of standard parameters and results are developed and applications to specific areas are included.

38790 (CONF-860426—4) Total volatile organic compounds (VOC) in the indoor air of east Tennessee homes. Gammage, R.B.; White, D.A.; Higgins, C.E.; Buchanan, M.V.; Guerin, M.R. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011774.

From Symposium on measurement of toxic air pollutants; Raleigh, NC, USA (27 Apr 1986).

Measurements of total VOC were made in the wintertime in eight homes in east Tennessee. The mean concentration of total VOC indoors was 1.03 mg/m^3 with a range in concentration of 0.09 to 3.67 mg/m^3. The corresponding values for air samples collected out of doors were 0.08 mg/m^3 and 0.003 to 0.44 mg/m^3. Hence the indoor-to-outdoor ratios of concentrations were about 10:1. There were marked differences in both the total loadings and complexities of VOC between different homes and temporally within a given home. About 10L samples of air were drawn through composite sorbent traps containing Tenax GC and two different carbonaceous resins. The trapped VOC were desorbed thermally and analyzed by GCFID. The counts from all peaks in the chromatograms were integrated and used to estimate total VOC relative to the FID response to a standard composed of chlorinated and non-chlorinated, aliphatic and aromatic hydrocarbons. The highest volatility VOC that we measured and included in our definition of total VOC were C_4+ alkanes, C_1+ chlorinated hydrocarbons, and C_2+ oxygenated hydrocarbons. Consideration is given to the types of compound that should be included in definitions of total VOC.

38791 (CONF-860606—7) Screening polynuclear aromatic pollutants in ambient and indoor air by synchronous luminescence. Vo-Dinh, T.; Miller, G.H.; Wilson, N.K. (Oak Ridge National Lab., TN (USA); Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Monitoring and Systems Lab.). 1986. Contract AC05-84OR21400. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011506.

From Air Pollution Control Association annual meeting and exhibition; Minneapolis, MN, USA (22 Jun 1986).

This paper discusses the results of a field study designed to evaluate a screening procedure based on synchronous luminescence, for ranking air samples according to their total PNA content. The SL technique can be used not only for chemical detection, but also for monitoring biological markers, such as carcinogen-DNA adducts in human biological fluids due to exposure to PNA pollutants.

38792 (CONF-8505156—4) Effects of acid rain, alone and in combination with gaseous pollutants, on growth and yield of crop plants. Shriner, D.S.; Johnston, J.W. Jr. (Oak Ridge National Lab., TN (USA)). 1985. Contract AC05-84OR21400. 23p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011977.

From NATO ARW conference on effects of acidic deposition on forests, wetlands, and agricultural ecosystems; Toronto, Canada (12 May 1985).

Greenhouse, growth chamber, and field experiments were conducted to determine the response of crop plants to levels of acidity in simulated rain. The major objectives were: to determine the levels of acidity in rain that alter crop productivity; to evaluate varietal differences in crop response; and to determine the response of crop plants to the combined stress of acid rain and gaseous pollutants, primarily ozone. Results showed additive effects rather than synergistic ones.

38793 (DOE/BP—00098-2) Indoor air quality control techniques: a critical review. Fisk, W.J.; Spencer, R.K.; Grimsrud, D.T.; Offerman, F.J.; Pederson, B.; Sextro, R. (Lawrence Berkeley Lab., CA (USA)). Sep 1985. Contract AC03-76SF00098. 252p. (LBL—16493; EEB-Vent—84-6). NTIS, PC A12/MF A01; 1; GPO Dep. File Number DE86012269.

The control techniques discussed in this study were taken into consideration by BPA when expansion of the Residential Weatherization Program was being assessed. Many of these techniques are now recommended in home weatherization literature distributed by BPA to program participants interested in energy conservation measures. This report currently represents the single most important reference tool available to researchers interested in addressing solutions to indoor air quality problems. It should serve as a valuable sourcebook.

38794 (DOE/ER/60227—T1) [Maintenance of a rural precipitation chemistry center at Whiteface Mountain]. Kadlecek, J.A. (State Univ. of New York, Albany (USA). Atmospheric Sciences Research Center). [1986]. Contract FG02-84ER60227. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011551.

Unique features of Whiteface Mountain site are described along with sampling frequency and handling procedures for meteorological data in the MAP3S program. Wind velocity, pressure, temperature, relative humidity, ozone concentration and weather maps are collected hourly. Samples are processed the same day the event ends. (PSB)

38795 (DOE/ER/60306—1) Videoteleconference project on the atmospheric carbon dioxide problem. Scientific issues and research needs. Final report. (Sigma Xi, the Scientific Research Society, New Haven, CT (USA)). May 1986. Contract FG02-85ER60306. 108p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86012097.

The purpose of the teleconference was to increase knowledge among scientists and students of the observed increases in atmospheric carbon dioxide in recent decades, and especially to stimulate young scientists to undertake research on carbon dioxide-related problems. This purpose was achieved partly through the teleconference itself, involving approximately 3000 participants at 58 remote sites throughout North American who were able to ask questions and make comments directly to the invited panelists in Washington, DC. The purpose was also achieved through the production of a 60-minute edited videotape of teleconference highlights. The videotape has been used as the basis of meetings of students and scientists, and has become part of university libraries for subsequent use in classes. The nature of the carbon dioxide problem is such that significant effects on many aspects of the natural environment and human endeavors are possible within the next few decades. The research required spans many scientific disciplines and requires cooperation and understanding among scientists. The teleconference and videotape, using Sigma Xi's cross-disciplinary structure, extended knowledge and should stimulate research related to the CO_2 problem.

38796 (DOE/FE/60181—199) Chemical characterization of electrostatic precipitator ashes from pressurized hydrated-lime injection tests. Henke, K.R.; Moretti, C.J. (North Dakota Univ., Grand Forks (USA). Energy Research Center). May 1986. Contract FC21-83FE60181. 17p. (CONF-8605117—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010576.

From International conference on the development of alternative energy sources and the lessons learned since the oil embargo; Grand Forks, ND, USA (23 May 1986).

Precipitator ashes were collected from four pressure hydrated-lime injection tests at the Hoot Lake utility plant in Minnesota.

The commercial feasibility of pressure-hydrated lime SO_2 control processes will partially depend on the chemistries of the solid wastes and their disposal requirements. The chemistries of the four precipitator ashes were determined by x-ray fluorescence, x-ray diffraction, and aqueous leaching tests. None of the EP or ASTM batch leachates exceeded RCRA standards; however, once sodium sulfate washed out of the columns barium concentrations in the column leachates increased significantly. Abundant soluble sulfate maintains low barium concentrations in the batch leachates. Most of the barium in the bulk ashes exists as water-soluble barium chloride or other phases. Calcium compounds in the precipitator ashes may reduce arsenic and boron concentrations in the alkaline leachates. The high concentrations of barium in some of the column leachates were not predicted by batch leaching, and is an example of the ability of column leaching to provide complementary data to batch leaching results.

38797 **(DOE/PC/73225—T2) Evaluation of the NOXSO combined NO/sub x/SO_2 flue gas treatment process.** Haslbeck, J.L.; Neal, L.G.; Perng, C.P.; Wang, C.J. (NOXSO Corp., Library, PA (USA)). Apr 1985. Contract FC22-84PC73225. 146p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86007434.

The report is organized in six chapters. Chapter 2 is a brief description of the NOXSO process. Chapter 3 contains a description of the regeneration studies directed toward a better understanding of the chemistry. This work is continuing and we expect a separate paper to be published on the sorbent surface chemistry in the next few months. Chapter 4 provides data on sorbent attrition. These studies include a long-term physical test and 45 chemical cycles on a single sorbent batch. Chapter 5 gives the results of a very detailed study of the corrosion problems encountered in the test program and presents several solutions to these problems. Chapter 6 presents a new cost study of the NOXSO process.

38798 (EPRI-CS/EA/EL—4480, pp 6.26-6.32) **PCB environmental transport and fate modeling.** Lingle, J.W. (Wisconsin Electric Power Co., Milwaukee). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

New mathematical modeling tools have recently been developed through research funded by the Electric Power Research Institute that predict the environmental transport and fate of PCBs from spills of dielectric fluid from electrical equipment such as capacitors and transformers. The models used, the input data required, and the application of the models to several PCB spills are discussed. The PCB Off-Site Model (POSSM) is the main core model used to predict the partitioning of PCBs into various environmental pathways. The POSSM model can be used with other off-site models to predict the movement of PCBs to the atmosphere, rivers, lakes, and groundwater. Other models used in this analysis include PTDIS, an EPA air pollution model, and EXPOSE, a model developed to calculate the dose of PCB to receptors based on potential exposure pathways such as inhalation, dermal contact, or ingestion. The models allow the user to examine a variety of cleanup scenarios and the resultant impact on exposure potential. Additional work is necessary to field test the models to determine the accuracy of the predictions. 3 references, 3 figures, 1 table.

38799 (EPRI-CS/EA/EL—4480, pp 7.26-7.39) **PCBs fires: preliminary correlation of chlorobenzene and PCB contents of the fluid with PCDF and PCDD contents of soot.** desRosiers, P.E.; Westfall, B.; Campbell, B.; Lee, A. (Environmental Protection Agency, Washington, DC). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

PCBs, PCDDs, and PCDFs are subject to new regulations promulgated under the Toxic Substances Control Act and the Resource Conservation and Recovery Act. The finding of PCDDs and PCDFs in PCBs could restrict disposal options for PCBs. A review of major fire incidents in the United States indicates that PCDDs have been found only in the Binghamton, NY, transformer fire incident. Laboratory combustion studies further support PCDFs formation from PCBs and PCDDs from chlorobenzenes. No PCDDs were found in analyses of fluids from transformers involved in transformer fire incidents. PCDFs do not appear to increase in PCBs askarel fluids from normal usage in electrical equipment. 15 references, 6 tables.

38800 (LMF—114, pp 30-34) **Lithium combustion aerosol reactions in air containing carbon dioxide and water vapor.** Eidson, A.F.; Allen, M.D.; Lykos, A.N.J. Dec 1985. NTIS, PC A23/MF A01. File Number DE86008522.

In Inhalation Toxicology Research Institute annual report, October 1, 1984-September 30, 1985.

Chain-aggregate lithium combustion aerosols were generated in dry, CO_2-free air prior to reaction with 0%, 0.10%, 0.50%, 1.0%, 1.75%, or 5.0% CO_2 in air at 51% to 55% relative humidity at 37°C. This was done to simulate the possible interactions of lithium combustion aerosols with CO_2 and H_2O in the atmosphere and respiratory tract. Aerosols were analyzed at 1-sec intervals during the first 12 sec after mixing and at 32 and 47 sec. There was no conversion to Li_2CO_3 in CO_2-free air, but there was 55% to 80% conversion within 1 sec after mixing of aerosols with all CO_2-enriched atmospheres. The extent of conversion to Li_2CO_3 was dependent on the molar CO_2/LiOH ratio in the range from 0 (0.0% CO_2) to 17 (1.0% CO_2), but was 78% at higher ratios. Changes in particle size distribution during the reaction were not sufficient to affect deposition patterns in the respiratory tract. 5 references, 3 figures.

38801 **(MIL—7-84) Program and data description for the environment model.** Christensen, B. (Risoe National Lab., Roskilde (Denmark)). Jun 1984. 34p. On loan from Risoe Library, DK-4000 Roskilde, Denmark.

EFP-82.

Description of the program which calculates the consequences from air pollution. The program consists of three parts: A dispersion model which calculates dispersion of pollutants from power plants to areas, a soil chemistry model and a crop uptake model. Further on a description of the basic data files containing information about: Meteorology, areas, cities, power plants, crops, pollutants and soil types. (author).

38802 **(NILU-OR—7/85) Field experiments to study the dispersion of air pollutants from the Andorra (Teruel) power plant. Plan.** Sivertsen, B. (Norsk Inst. for Luftforskning, Lillestroem). Feb 1985. 67p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86752313.

A plan for studying the transport and dispersion of air pollutants from the Andorra (Teruel) coal fired power plant in Spain is presented. Sulfur hexafluoride (SF^6) tracer techniques with extensive ground level sampling of SF^6, combined with air craft measurements of the tracer, SO^2, NOsub(x) and particles are proposed. 7 references.

38803 **(PB—86-182086/XAB) Measurement of air pollution and other factors relating to the practice of straw and stubble burning.** Larkin, S.B.C.; Lee, M.; McInnes, G.; Sharp, M.; Simmonds, A.C. (Warren Spring Lab., Stevenage (UK)). 1985. 190p. (LR—18(AP)M). NTIS, PC A09/MF A01.

An assessment of the emissions into the atmosphere and deposition of particulate material arising from the practice of straw and stubble burning was carried out in the summer of 1984 using a number of samplers to cover the range of particle sizes found during a series of small-scale surrogate trials and full-scale field trials. Emission factors derived from ambient pollutant concentrations, associated deposition rates, and meteorological measurements were used to assess the procedures used to burn the straw and stubble; recommendations were made to reduce the air-pollution impact.

38804 **(PB—86-182847/XAB) Trajectory analysis of ozone episodes at a rural site in Sibton, Suffolk - 1980-1983.** Simpson, D.; Davies, S. (Warren Spring Lab., Stevenage (UK)). 1985. 48p. (LR—536(AP)M). NTIS, PC A05/MF A01.

The report seeks to illustrate the variety of back-trajectories occurring during periods of elevated ozone concentrations observed at the Warren Spring Laboratory's rural site of Sibton, Suffolk, over the period 1980-1983. Analysis of meteorological data and ambient pollution measurements is used to characterize and, where possible, explain the different types of episode observed.

38805 **(PB—86-182854/XAB) Variation of precipitation composition with altitude: a feasibility study.** Barrett, C.F.; Goldsmith, A.L.; Hall, D.J.; Irwin, J.G. (Warren Spring Lab., Stevenage (UK)). 1985. 57p. (LR—534(AP)M). NTIS, PC A06/MF A01.

A feasibility study was carried out on the variation of precipitation composition with height. The study divides into two parts. A study of rain contamination was carried out at the Institute of Hydrology study catchment at Balquhidder. The limited number of results obtained were consistent with the hypothesis that rain composition, when averaged over a number of rain events, is constant with height. More work is needed but the methodology adopted was shown to be sound. As much of the precipitation on high ground in Scotland falls as snow, it was necessary to extend the study to snow. The accurate measurement of snow in other than calm or near-calm conditions is a difficult problem that has had extensive study over many years, and a new approach based on aerodynamic principles was adopted. Field trials were very encouraging but showed that some refinements are necessary.

38806 **(PB—86-183811/XAB) Environmental assessment of a commercial boiler fired with a coal/waste plastic mixture. Volume 1. Technical results. Final report, July 1983-July 1984.** DeRosier, R.; Lips, H.I.; Waterland, L.R. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Apr 1986. 153p. NTIS, PC A08/MF A01.

The report gives results of comprehensive emissions testing and laboratory analyses of a stoker-fired commercial boiler firing a coal/waste plastic mixture. In one test, the unit fired its typical coal fuel; in the other, shredded waste polyethylene terephthalate (PET) beverage bottles were added to the coal to about 16% by weight in the mixed fuel. NOx, total unburned hydrocarbon, and solid particulate were relatively unchanged for the two tests, as was the emitted particle size distribution. SOx emissions decreased with the coal/PET fuel in keeping with its lowered sulfur content; average CO emissions were also decreased. Flue-gas emissions of most trace elements were comparable for both tests, as were the trace-element compositions of corresponding ash streams. However, lead emissions were significantly increased for the coal/PET fuel, reflecting an increased lead content of the mixed fuel. The cyclone hopper ash for the coal/PET test had consistently lower leachable trace element and anion content than for the coal fuel test. Total flue-gas organic emissions were comparable for both tests, in the 1 mg/dscm range; however, levels of several semivolatile priority pollutants were higher for the mixed fuel.

38807 **(PB—86-183829/XAB) Environmental assessment of a commercial boiler fired with a coal/waste plastic mixture. Volume 2. Data supplement. Final report, July 1983-July 1984.** DeRosier, R.; Lips, H.I.; Waterland, L.R. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Apr 1986. 206p. NTIS, PC A10/MF A01.

The report gives results of comprehensive emissions testing and laboratory analyses of a stoker-fired commercial boiler firing a coal/waste plastic mixture. In one test, the unit fired its typical coal fuel; in the other, shredded waste polyethylene terephthalate (PET) beverage bottles were added to the coal to about 16% by weight in the mixed fuel. NOx, total unburned hydrocarbon, and solid particulate were relatively unchanged for the two tests, as was the emitted particle size distribution. SOx emissions decreased with the coal/PET fuel in keeping with its lowered sulfur content; average CO emissions were also decreased. Flue-gas emissions of most trace elements were comparable for both tests, as were the trace-element compositions of corresponding ash streams. However, lead emissions were significantly increased for the coal/PET fuel, reflecting an increased lead content of the mixed fuel. The cyclone hopper ash for the coal/PET-test had consistently lower trace element and anion content than for the coal fuel test. Total flue-gas organic emissions were comparable for both tests, in the 1 mg/dscm range; however levels of several semivolatile priority pollutants were higher for the mixed fuel.

38808 **(PB—86-186798/XAB) Environmental nitroarenes: an attempt to understand their mutagenic and carcinogenic properties.** Rosenkranz, H.S.; McCoy, E.C.; Mermelstein, R.; Klopman, G. (Case Western Reserve Univ., Cleveland, OH (USA)). 1986. 36p. NTIS, PC A03/MF A01.

This report deals primarily with subsequent advances and an attempt to place the emerging knowledge into perspective. Nitroarenes have been found in xerographic toners, typewriter ribbons, and cigarette-smoke condensate (e.g., mainstream). The reason for the present concern about the possible health hazards of these chemicals is derived from the realization that they are present in diesel emissions, in fly ash derived from coal-conversion processes, and in the sidestreams of cigarette smoke. Thus, they are not only ubiquitous in the atmosphere but may also be present in high concentrations in confined spaces, such as the office and home environment, primarily as the result of cigarette smoking. Literally hundreds of nitroarenes have been detected in diesel emissions and in the ambient atmosphere. It is now realized that nitroarenes are perhaps ubiquitious as a result of the facile nitration by oxides of nitrogen (in the presence of traces of acids) of polycyclic aromatic hydrocarbons (PAHs) emitted during the course of incomplete combustion processes. Obviously, the recognition of hundreds of environmental nitroarenes means that it will not be practical to prepare sufficient quantities of each of these and to determine their mutagenic and carcinogenic potentials. Accordingly, the approach has been to study structural commonalities that might be useful in predicting biological properties. Some of the preliminary findings are reported herein.

38809 **(PB—86-186939/XAB) Review of current research and long-term research needs in air pollution.** Stern, A.C. (North Carolina Univ., Chapel Hill (USA)). 1985. 231p. NTIS, PC A11/MF A01.

Current research and long-term research needs of air pollution are reviewed and assessed in the following areas: pollution definition and characterization; atmospheric chemistry; measurement and monitoring of ambient air and sources; effects of human health and welfare, vegetation, animals, aquatic life, materials and structures; air pollution meteorology and modeling; engineering control; and regulatory control. The work spans NSF program categories including atmospheric sciences, chemical and process engineering, chemistry, biotic systems, materials research, mechanical engineering, physics, physiology, research instrumentation, and economic sciences. An attempt is made to analyze these research areas to determine how the research could be made more useful and effective by merging and crossing disciplinary lines with interdisciplinary approaches. An appendix provides a detailed listing of air pollution research projects in progress during 1985.

38810 **(PB—86-187770/XAB) Guidelines for using OZIPM-3 with CBM-X or optional mechanisms. Volume 1. Description of the Ozone Isopleth plotting package, Version 3. Final report, August 1982-July 1985.** Hogo, H.; Whitten, G.Z. (Systems Applications, Inc., San Rafael, CA (USA)). Jan 1986. 253p. NTIS, PC A12/MF A01.

A computer program, called Ozone Isopleth Plotting with Optional Mechanisms/Version 3 (OZIPM-3), was developed. The program enables the use of a new Carbon Bond Mechanism (CBM-X) for EKMA control-strategy calculations. The OZIPM-3 program also has the capability to accept a chemical mechanism other than the default CBM-X that is internally stored in the program. Volume 1 serves as the User's Manual for OZIPM-3. It contains a detailed description of how OZIPM-3 operates. It also contains a thorough discussion of the different input and output options available to the user when exercising either the default CBM-X mecha-

nism or an optional mechanism. Five examples of OZIPM-3 simulations are presented.

38811 **(PB—86-187788/XAB) OZIPM-3 (Ozone Isopleth Plotting with optional mechanisms, Version 3) source code. Software.** Dodge, M.C.; Whitten, G.Z. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). Dec 1985. vp. (EPA/600/3—86/004C). NTIS, PC A08/MF A01.

A software package has been developed to enable a user to estimate EKMA control strategies using a new Carbon Bond Mechanism known as the CBM-X. The program is called Ozone Isopleth Plotting with Optional Mechanisms/Version 3 (OZIPM-3). The program has the capability to accept a chemical mechanism other than the default CBM-X that is internally stored in the program. Included with the source code are five examples of OZIPM-3 simulations. The use of the OZIPM-3 program is described in the EPA Report Guidelines for Using OZIPM-3 with CBM-X or Optional Mechanisms.

38812 **(PB—86-190048/XAB) Characterization of organic emissions from selected materials in indoor use.** Tichenor, B.A.; Mason, M.A. (Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab.). Apr 1986. 17p. NTIS, PC A02/MF A01.

The paper provides data from small-chamber testing of a latex caulk and a floor adhesive, as part of EPA's ongoing evaluation of organic emissions from indoor materials. Among the conclusions drawn from presented data are: (1) low air-exchange rates promote high concentrations of organic vapors emitted from indoor sources. (2) high air-exchange rates promote rapid vaporization of organics, leading to high emission factors in the initial testing phase; (3) cumulative mass emissions at the end of the testing period are approximately equal for all air-exchange rates; and (4) organic emissions for different materials vary widely. Further research could provide additional valuable information, including identifying critical parameters affecting chamber emissions for a variety of building materials and consumer products. Research is underway to determine how changes in temperature and humidity affect organic emissions. Efforts continue to improve upon available models for relating chamber test conditions to emissions.

38813 **(PB—86-190071/XAB) Methodology for designing air-quality-monitoring networks: 2. Application to Las Vegas, Nevada, for carbon monoxide.** McElroy, J.L.; Behar, J.V.; Meyers, T.C.; Liu, M.K. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Monitoring and Systems Lab.). 1986. 25p. (EPA/600/J—86/036). NTIS, PC A02/MF A01.

An objective methodology presented in a companion paper (Liu et al., 1986) for determining the optimum number and disposition of ambient air-quality stations in a monitoring network for carbon monoxide is applied to the Las Vegas, Nevada, area. The methodology utilizes an air-quality simulation model to produce temporally-varying air quality patterns for each of a limited number of meteorological scenarios representative of the region of interest. These air-quality patterns in turn serve as the data base in a two-step procedure for the identification and ranking of the most-desirable monitoring locations (step 1) and the removal of redundancies in spatial coverage among the desired locations (step 2).

38814 **(PB—86-190089/XAB) Methodology for designing air-quality-monitoring networks. 1. Theoretical aspects.** Liu, M.K.; Avrin, J.; Pollack, R.I.; Behar, J.V.; McElroy, J.L. (Systems Applications, Inc., San Rafael, CA (USA)). 1986. 13p. NTIS, PC A02/MF A01.

An objective methodology is presented for determining the number and disposition of ambient air-quality stations in a monitoring network for the primary purpose of compliance with air-quality standards. The methodology utilizes a data base with real or simulated data from an air quality dispersion model for application with a two-step process for ascertaining the optimal monitoring network. In the first step, the air-quality patterns in the data base are collapsed into a single composite pattern through a figure-of-merit (FOM) concept. The most-desirable locations are ranked and identified using the resultant FOM fields. In the second step the network configuration is determined on the basis of the concept of spheres of influence (SOI) developed from cutoff values of spatial-correlation coefficients between potential monitoring sites and adjacent locations. The minimum number of required stations is then determined by deletion of lower-ranked stations whose SOI's overlap. The criteria can be set to provide coverage of less than some fixed, user-provided percentage of the coverage of the SOI's of the higher-ranked stations and for some desired level of minimum detection capability of concentration fluctuations.

38815 **(PB—86-190287/XAB) Meeting atmospheric-modeling requirements for utility data.** Pechan, E.H.; Wilson, J.H.; Graves, K.K.; Mobley, J.D. (Hengel Associates, Rapid City, SD (USA)). Apr 1986. 23p. NTIS, PC A02/MF A01.

The paper examines emission inventory data available for the utility industry and determines how well the data meet atmospheric modeling requirements. Utilities are important from the perspective of their contribution to total SO_2 and NOx emissions, and also because data-reporting requirements for utility plants allow consistent emission estimates to be made for each U.S. facility. It was found that publicly available data on utilities can be used to estimate plant and unit-level emissions by month using consistent methods. Needs for data for time periods of less than a month (weekly, daily, hourly) are more difficult and costly to meet. Continous-emission-monitoring data hold promise for providing emissions information for time periods as short as 1 hour, but these instruments are in place at a limited number of units. Hourly emissions for nonmonitored units would have to be estimated using rough approximations; e.g., seasonal hourly load profiles. If it is important for modelers to know that utility units were not operating for a day or a week during a certain period, special studies will have to be instituted to collect the information.

38816 **(PB—86-190295/XAB) Development of the NAPAP (National Acid Precipitation Assessment Program) emissions inventory to support applications of the Eulerian regional acid deposition model.** Sellars, F.M.; Mobley, J.D. (GCA Corp., Bedford, MA (USA)). Apr 1986. 19p. NTIS, PC A02/MF A01.

The paper describes the processes and data sources used to develop temporal, spatial, and species allocation factors for the National Acid Precipitation Assessment Program (NAPAP). NAPAP has charged its task group on Emissions and Controls with the development of inventories of acid-rain precursor emissions from anthropogenic sources. To support applications of the Eulerian Regional Acid Deposition Model (RADM), the 1980 NAPAP Annual Emissions Inventory was further resolved. Temporal allocation of annual emissions to hourly emissions estimates for a typical weekday, Saturday, and Sunday in each season; spatial allocation of county-level area source and minor point-source emissions to 63,000 20 x 20 km grid cells; and species allocation of NOx to NO and NO_2, TSP to alkalinity classes, and VOC to 29 photochemical reactivity classes were performed.

38817 **(PB—86-190303/XAB) EPA (Environmental Protection Agency) research on indoor air quality.** Tucker, W.G. (Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab.). Apr 1986. 15p. (EPA/600/D—86/093). NTIS, PC A02/MF A01.

The paper discuases EPA's research program on indoor air quality. Now in its third year, it is a broad-based program that includes: field surveys of pollutant concentrations in homes, characterization of emissions from sources, health studies of genotoxic and irritant/neurobehavioral effects, and a limited amount of research and development of indoor air-quality controls. The primary emphasis in all areas is on organic compounds, except for controls, where emphasis is on particles (although even there the orientation is partly organic, since indoor-air respirable particles are mostly organic condensation aerosols). The area of greatest overall emphasis has been on a national field survey of air-quality in homes. The field survey will obtain distributions of exposure estimates to indoor and outdoor air pollutants. It will help confirm whether indoor concentrations are in fact much higher than outdoor concentra-

tions, as suggested by several small field studies that have been done to date. Research on indoor sources, health effects, and indoor air quality controls will continue to be significant components of the program. In addition, EPA's basic programs in air pollution research are likely to be increasingly influenced by indoor air-quality concerns.

38818 **(PB—86-190444/XAB) Technical manual: hood system capture of process fugitive particulate emissions. Final report, September 1983-September 1985.** Kashdan, E.R.; Coy, D.W.; Spivey, J.J.; Cesta, T.; Goodfellow, H.D. (Research Triangle Inst., Durham, NC (USA)). Apr 1986. 183p. NTIS, PC A09/MF A01.

The manual provides to regulatory officials--charged with the responsibility of reviewing hood systems for capture of process fugitive emissions--with a reference guide on the design and evaluation of hood systems. Engineering analyses of the most-important hood types are presented. In particular, consideration is given to design methods for local and remote capture of buoyant sources, and enclosures for buoyant and inertial sources. A unique collection of case studies of actual or representative hood systems has been included to provide insight into the evaluation of existing systems or the design of a planned system.

38819 **(PB—86-191376/XAB) Indoor air pollution source data base. Report for August 1985-February 1986.** Crum, J.M. (Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab.). Apr 1986. 11p. (EPA/600/D—86/082). NTIS, PC A02/MF A01.

The paper, directed to individuals interested in indoor air pollution, is an introduction to, and directions for the use of, the indoor air-pollution-source database (also known as the indoor air-source-emissions data base). The database is a computerized system containing source characterization studies done in the U.S. and abroad. It addresses the entire range of indoor air sources: combustion, material, and activity sources. It provides ready access to such information as: emission factors determined for each of the pollutants and sources tested, data about the test facility, conditions of the experiment, sampling and analytical data, and an abstract of each publication. The program also includes options for researchers carrying out their own source-characterization studies, allowing them to add their own data to the data base and to arrange the data in a format suitable for searching. The database is currently available in a dBase III version or a Clipper-compiled version.

38820 **(PB—86-191558/XAB) Sample design considerations for indoor-air-exposure surveys.** Mage, D.T.; Cox, B.G.; Immerman, F.W. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Monitoring and Systems Lab.). Apr 1986. 16p. (EPA/600/D—86/079). NTIS, PC A02/MF A01.

Recent studies have shown that the traditional practice of monitoring outdoor (ambient) air quality leads to little information regarding the exposures of people in indoor surroundings. Consequently, EPA has begun a series of studies to determine the air-pollution exposures people are subjected to in their daily nonoutdoor activities at home, in traffic, and at work. The paper describes the factors that should be considered in developing a survey to describe the air-pollution exposures that people experience in their home environment. There is little previous experience in survey design for indoor-air-pollution exposure per se. However, the field of survey design for measurement of people's attitudes, preferences, and attributes is well developed. An extensive literature exists that describes general sampling techniques for performing these surveys. Some types of surveys, such as health-care surveys or business surveys, are best addressed by particular types of survey designs. For example, the design issues for health-care surveys are discussed in detail by Cox and Cohen. The paper discusses the design considerations that make indoor-air-exposure surveys, where human subjects are recruited either to carry personal monitors or to allow monitoring in their homes, different from the traditional surveys of opinions and attitudes.

38821 **(PB—86-192044/XAB) National air-quality and emissions-trends report, 1984.** Hunt, W.F.; Curran, T.C.; Faoro, R.B.; Frank, N.H.; Freas, W. (Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards). Mar 1986. 221p. (EPA/450/4—86/001). NTIS, PC A10/MF A01.

The report presents national and regional trends in air quality from 1975 through 1984 for total suspended particulate, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone and lead. Air-pollution trends were also examined for the 5-year period (1980-84) to take advantage of the larger number of sites and the fact that the data from the post-1980 period should be of the highest quality. Both national and regional trends in each of the major pollutants are examined, as well as complimentary air-quality trends in 1984. National air-quality trends are also presented for both the National Air Monitoring Sites (NAMS) and other site categories. In addition to ambient air quality, trends are also presented for annual nationwide emissions. These emissions are estimated using the best-available engineering calculations; the ambient levels presented are averages of direct measurements.

38822 **(PB—86-192549/XAB) Peak exposures to nitrogen dioxide and study design to detect their acute health effects.** Goldstein, I.F.; Andrews, L.R. (Columbia Univ., New York (USA). School of Public Health). Apr 1986. 17p. NTIS, PC A02/MF A01.

Findings on continuous exposure to nitrogen dioxide by persons cooking a meal on a gas stove are presented. In addition, peak levels of NO_2 at different heights above the floor and at various distances from the stove while the range and oven are in operation are reported for 24 homes. A study design to detect the health effects of short-term exposures to high levels of nitrogen dioxide ranging from 0.20 ppm to over 1.5 ppm on pulmonary function and respiratory symptoms in asthmatic and non-asthmatic subjects is described. The continuous exposure to nitrogen dioxide of the study subjects before, during and after cooking a dinner on a gas stove is determined using a continuous nitrogen dioxide monitoring instrument. Lung-function tests are performed and symptom questionnaires are administered throughout the study period to assess both health effects and changes in pulmonary function associated with the above exposures.

38823 **(PB—86-194248/XAB) Guidelines for using OZIPM-3 with CBM-X or optional mechanisms. Volume 2. Computer code. Final report, August 1982-July 1985.** Hogo, H.; Whitten, G.Z. (Systems Applications, Inc., San Rafael, CA (USA)). Jan 1986. 165p. NTIS, PC A08/MF A01.

A computer program, called Ozone Isopleth Plotting with Optional Mechanisms/Version 3 (OZIPM-3), was developed. The program enables the use of a new Carbon Bond Mechanism (CBM-X) for EKMA control strategy calculations. The OZIPM-3 program also has the capability to accept a chemical mechanism other than the default CBM-X that is internally stored in the program. Volume 2 contains the FORTRAN listing of the computer code. A magnetic tape of this code is also available.

38824 **(PB—86-194420/XAB) Investigation of the formation of a Portland Cement plant detached plume.** Cheney, J.L.; Knapp, K.T. (Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab.). May 1986. 112p. (EPA/600/3—86/029). NTIS, PC A06/MF A01.

A gaseous and particulate-source emissions sampling program was conducted at a Portland Cement production plant in Rapid City, South Dakota. The study was conducted to determine the cause of the formation of an opaque detached plume from the plants' dry process kiln. The instack opacity of the emissions was less than 10% while the opacity of the plume five to ten stack diameters from the mouth of the stack was in excess of 40%, thus giving an appearance of a detached plume. The sampling and analysis program included particulate emissions measurements, particle sizing and composition, and measurements of gaseous and particle ammonia, chloride, fluoride, and sulfur dioxide. Extensive process materials sampling and analysis were also conducted. Based on the resulting data, one conclusion is that the opaque detached plume is

the result of ammonium chloride particles formed by the reaction of gaseous ammonia and hydrochloric acid. It was also found that the ammonia in the cement plant was generated from the shale portion of the raw products when the raw product was passed through the heat exchanger.

38825 **(PB—86-195229/XAB) How good are ambient air-pollution measurements.** Rhodes, R.C.; Evans, E.G. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Monitoring and Systems Lab.). May 1986. 12p. (EPA/600/D—86/100). NTIS, PC A02/MF A01.

In accordance with Federal regulations, state and local air-pollution-control agencies have, since January 1, 1981, been performing special checks of their ambient air-measurement systems to assess the precision and accuracy of the monitoring data. The measurement methods involved are those for total suspended particulate, nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, and lead. The precisions of the measurement systems are estimated by some type of replicate measurement, including the use of collocated samplers. Accuracies of the measurement systems are estimated by measurement of, or comparison with, reference materials or devices. Because the variations of imprecision and inaccuracy are usually proportional to pollution concentration levels, the assessments are expressed on a percentage basis. The precision and accuracy assessments are reported to EPA. Annual EPA reports are issued to summarize and evaluate the data quality. Appreciable variation of data quality exists across the regions, states, and local agencies of the nation.

38826 **(SBI-MEDD—56) Nitrogen oxides in kitchens with gas stoves. A pilot project for the evaluation of a test method.** Jespersen, R. (Statens Byggeforskningsinstitut, Hoersholm (Denmark)). 1986. 56p. (In Danish). Statens Byggeforskningsinstitut, P.O. Box 119, DK-2970 Hoersholm, Denmark. Price: Dkr. 51,25.

This report presents the results of a pilot study conducted in order to determine the indoor levels of NO and NO/sub x/, generated by gas combustion in kitchen stoves. 24 hours cintinuous monitoring was carried out in 16 homes in Copenhagen and surrounding areas during the summer period May-June, 1985. The measurements were carried out in kitchens with natural gas (8 places), city gas (7 places) and electric stoves (1 place). The concentrations of NO_2 were calculated as the difference between NO/sub x/ and NO. The 24 hours average concentration of NO_2 in kitchens with gas stoves ranged from 0.014 to 0.059 ppM with a mean value of 0.028 ppM and a standard deviation of +-0.011 ppM. The maximum one hour value ranged from 0.045 to 0.384 ppM with a mean value of 0.115 ppM and a standard deviation of +- 0.088 ppM. The mean time in which the kitchen stoves were used (top burners and ovens) was 2.5 hours per 24 hours. A small difference in No_2 concentrations between natural gas and city gas was found.

38827 **(SMHI-RMK—41) Local scale plume model for nitrogen oxides. Model description.** Persson, C.; Funkquist, L. (Swedish Meteorological and Hydrological Inst., Norrkoeping. Meteorology and Climatology). Sep 1984. 23p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752270.

A plume dispersion model on local scale (0 to approximately 20 km) including atmospheric chemistry for nitrogen is developed. The purpose of the study is to obtain a practical air quality model wich can be used in environmental planning for eg coal fired power plants. Problems concerning both high concentrations of NO_2 in the air and deposition of different nitrogen compounds to the ground is considered. The instantaneous plume dilution is described - assuming total mixing within the plume - as a function of emission parameters and meteorological conditions. The interplay of emissions, instantaneous plume dilution, entrainment of polluted ambient air, meteorological conditions and atmospheric chemistry processes determines production or loss of the different compounds. On a local scale only six chemical reactions need to be included. On a somewhat larger scale the number of reactions needed increases substantially. For the numerical solution we have used the method by Gear. In order to obtain hourly mean values of different nitrogen oxides and long-term deposition values conventional Gaussian respectively K-formulation procedures are used. Meteorological input data are obtained from climatological observations and also generated by a boundery layer model. From the results it is obvious that the meteorological conditions and the ambient ozone concentration are of great importance for the relative amount of NO_2 in the plume. On a local geographical scale the plume chemistry is diffusion controlled. (Author).

38828 **(SVF—191) Utilization of by-product from the wet-dry flue gas desulfurization method.** Lindau, L. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Apr 1985. 190p. (In Swedish). NTIS (US Sales Only), PC A09/MF A01. File Number DE86752146.

In chapter 1, the problem is defined. The wet-dry FGD method was originally designed primarily as a throw-away process and produces a dry powder containing mainly calcium sulfite, but also smaller amounts of unreacted lime, fly ash and calcium chloride. There is no current way of using this type of material. In chapter 2, the material is characterized more in detail, i a with the aid of transmission electron microscopy. In chapter 3, the publicly available literature on the subject is reviewed. The fact is that this FGD process is fairly new and originally was intended as a throw-away process is the background to the relative paucity of published material. In chapter 4, the possibility of using the FGD product as a conditioner for municipal sewage sludge is considered. The basic idea is that very cheap alkali in the form of excess lime is available which can be used as a disinfectant and to decrease the leaching of trace elements. Concern for the long-term effect of a combination of a reducing environment (sulfite oxidation) and organic matter in terms of odour remains however. In chapter 5, thermal oxidation of the sulfite to anhydrite is considered. Anhydrite has an established use as a retarder in Portland cement e.g. West Germany. Successfull experiments to carry out the oxidation in a fluid bed reactor were carried out, and the material produced fullfills the relevant DIN norms. In chapter 6, some exploratory experiments using the FGD-product mixed with fly ash and Portland cement are reported and an application as material for roadbuilding is suggested.

38829 **(SVF—210) Measurements and analyses of flue gas performed at the waste incinerator plant of Aalidhem at Umeaa.** Mostroem, R.; Dahlgren, O.; Sandstroem, G. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Nov 1985. 198p. (In Swedish). NTIS (US Sales Only), PC A09/MF A01. File Number DE86752154.

One can note that emission of metals mostly depends on the fuel composition whereas that of CO, THC (=methane) and organic compounds mostly depends on the combustion conditions. The reduction of Hg- and Cd-emissions from the incineration plant may be performed either by separation of mercury and cadmium from the refuse fuel or from the flue gas. The emission of organic compounds is linked to furnace temperature and combustion efficiency. This applies to chlorinated benzens, chlorinated phenols, PAH, chlorinated PAH and phtalats, which generally increase at lower furnace temperatures. At the same time the emissions of these compounds decrease when combining the normal operation with oil-fire support (which comes into operation when the furnace temperature gets below 800 degree C). Chlorinated dioxins (PCDD) and dibenzofurans (PCDF) deviate from this pattern. There one can find no connection between emission quantities and operation conditions. Start-ups must be made by oil (alternatively by peat or wood residues/fuel chips) as the results show the same concentration in the flue gas at oil-fired start-ups as during normal operations. The emissions of chlorinated dioxins and dibenzofurans ought to be reduced during all operating conditions, which can be performed by improving the combustion conditions (avoiding cold air zones, checking up the combustion air, air/flue gas mixture etc). The following can also be stated: An improvement of the combustion is necessary if the CO-concentration is to be on a low and constant level (below 100 mg/Nm^3). The emission of hydrochloric acid is normal for this type of plant. A lower furnace temperature gives less emission. The emission of sulphur dioxide is about 160 mg/MJ power supply (or 80 mg S/MJ) during normal operation. The NOsub(x)-emission is at the expected level for oilfiring .(author).

38830 (TNO-CMP—86-01) Photochemical oxidants abatement policy and its regional rationale in the Netherlands. Builtjes, P.J.; Bovenkerk, M.; Zwerver, S. (Nijverheidsorganisatie TNO, Delft (Netherlands)). Apr 1986. 16p. (CONF-860803—4). TNO Bureau Milieu Projecten, P.O. Box 17, 2600 AE Delft, Netherlands.

From 7. world clean air congress and exhibition; Sydney, Australia (25 Aug 1986).

High oxidant levels do occur in Europe. In the Netherlands current ozone levels do approach or exceed the preliminary primary ambient air quality standard, while they exceed the secondary, also preliminary, standard. A growing number of experts relate damage to forests also to ozone. Damage to forests, crops and materials has been observed in the Netherlands and has also been expressed in monetary terms. Taking the scale of the problem into account long term objectives have to be formulated. Besides, the most effective route of abatement to meet these objectives should be established. Calculations in the framework of the Dutch Air quality management system provide information about this route as far as it regards NO/sub x/ and hydrocarbons and their role in ozone-formation. More specific and detailed calculations are underway in the bilateral German/Dutch PHOXA-Project (Photochemical oxidants and acid deposition). The European Commission and OECD are preparing similar calculations in close co-operation with PHOXA, using the same data-base and the same model. The EC itself and the separate member countries are preparing regulations for mobile and stationary sources. Roughly estimated the Netherlands and West Germany run about five years ahead of the EC-average in this context. These regulations will also result in reduction of NO/sub x/ and hydrocarbons. The paper analyses what these regulations mean for future oxidant levels and to what extent the objectives are expected to be met. The outlook for the future oxidant situation in the Netherlands is described. It is established which and to what extent further abatement is necessary. 3 figs., 1 tab., 22 refs.

38831 (UCID—20637) New temperature correlation for forced-ventilated compartment fires. Foote, K.L.; Alvares, N.J.; Pagni, P.J. (Lawrence Livermore National Lab., CA (USA); California Univ., Berkeley (USA). Dept. of Mechanical Engineering). 30 May 1986. Contract W-7405-ENG-48. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012002.

Forced-ventilated compartments are a common environment for fire growth in sealed or high-rise structures. Currently, no method exists for reliably estimating the fire hazard in these enclosures. Using data from compartment fires in the forced-ventilation facility at Lawrence Livermore National Laboratory (LLNL), a simple correlation has been developed following the methods of McCaffrey, Quintiere, and Harkleroad. The upper-layer temperature rise above ambient, $\Delta T = T/sub\ u/ - T/sub\ \infty/$, is given as a function of the fire heat-release rate, Q, the compartment mass-ventilation rate, m, the gas specific-heat capacity, c/sub p/, the compartment surface area, A/sub W/, and an effective heat-transfer coefficient based on t and h/sub k/. The nondimensional form of the best fit to the data is $\Delta T/T/sub\ \infty/ = 0.63\ (Q/mc/sub\ p/T/sub\ \infty/)/sup\ 0.72/\ (h/sub\ k/A/sub\ W//mc/sub\ p/)/sup\ -0.36/$. This confirms the correlation suggested by McCaffrey, et al. For their free-ventilation data, the coefficient increases to 0.77. All data are well fit by a coefficient of 0.7, while the powers remain unchanged. Alternatives for, limits, on, and the usefulness of such correlations are discussed.

38832 Removal of SO_2 from simulated flue gas by magnesia spray absorption: parameters affecting removal efficiency and products. Egan, Z.; Felker, L.K. (Chemical Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831). *Industrial and Engineering Chemistry Process Design and Development;* **25**: No. 2, 558-569(Apr 1986).

A bench-scale apparatus simulating a spray dryer was used to study magnesia flue gas desulfurization (FGD) technology combined with spray absorption techniques for the removal of SO_2 from flue gas. The use of magnesia spray absorption technology requires fewer processing steps, reduces slurry and sludge handling as compared with limestone slurry systems, and yields a saleable sulfur byproduct. Simulated flue gases (SO_2 in N_2) were mixed with heated $Mg(OH)_2$ slurries and sprayed into a heated glass vessel. The inlet and exit gases were monitored for SO_2 concentration. Ranges of experimental conditions were as follows: gas flow rate, 7-10 L/min; SO_2 concentration in the inlet gas, 0.099-1.07%; slurry composition, 0.5-10% $Mg(OH)_2$; slurry flow rate, 1-7 mL/min; inlet gas temperature, 107-115 °C; and dryer temperature, 73-114 °C. The SO_2 removal efficiency ranged from 28% to nearly 100%, depending primarily on the reaction stoichiometry [$Mg(OH)_2/SO_2$ mole ratio]. The solid products were $MgSO_3.3H_2O$ and $MgSO_3.6H_2O$, with the hexahydrate predominating at lower temperatures and higher humidities.

38833 Measurements of wind velocities in a street canyon. DePaul, F.T.; Sheih, C.M. (Argonne National Lab., IL). *Atmospheric Environment;* **20**: No. 3, 455-459(1986).

Measurements of wind velocities in an urban street canyon with a height-to-width ratio of about 1.4 were made when ambient winds aloft were approximately perpendicular to the street. The mean wind velocities were determined by analysis of trajectories of tracer balloons that were released in the canyon and photographed in rapid sequence. The trajectories indicate the presence of a primary vortex cell within the canyon, provided the ambient wind velocity exceeds 1.5-2.0 m s^{-1}. Measurements with hot-wire anemometers suggest that vehicular traffic at the street level is significant in increasing turbulence up to heights of approximately 7 m.

38834 Evaluation of the perfluorocarbon tracer technique for determining infiltration rates in residences. Leaderer, B.P.; Schaap, L.; Dietz, R.N. (Yale Univ. School of Medicine, New Haven, CT). *Environmental Science and Technology;* **19**: No. 12, 1225-1232(Dec 1985).

A simple passive perfluorocarbon tracer (PFT) technique, for determining air infiltration rates into homes and buildings, was evaluated in a well-defined environmental chamber under experimental conditions of (1) constant temperature and ventilation rate, (2) constant temperature but variable ventilation rate, and (3) variable temperature but constant ventilation rate. Two PFT sources of known emission rate and temperature dependence produced chamber concentrations of 100-300 nL/m^3 (parts per trillion). The average relative standard deviation for sampling and analysis of 16 paired samplers in experiment 1 was +/- 1.9 +/- 1.0%, and there was negligible consequence of sampler orientation. For a 3-fold variation in ventilation rates (experiment 2), the passive samplers accurately measured the average chamber tracer concentration, but the PFT-determined ventilation rate had a 10% negative bias. Temperature cycling differences of as much as 8 °C were accommodated to provide essentially no bias in the PFT-determined ventilation rate. The PFT technique is applicable to the expected range of conditions in homes and buildings.

38835 Climatological variability. Streets, D.G.; Lesht, B.M.; Shannon, J.D.; Veselka, T.D. (Argonne National Lab., IL). *Environmental Science and Technology;* **19**: No. 10, 887-893(Oct 1985).

A major problem with designing control strategies for acid deposition is that future deposition patterns must be simulated using past meteorological conditions. Emission reductions that would result from the implementation of a given strategy can be estimated, but efforts to predict what effect these reductions would have on deposition levels are hampered by uncertainty about future transport and deposition climatology. This paper examines how a control strategy might vary when optimized under different assumptions about future meteorological conditions. In particular it evaluates the variations in emission reductions and in emission control costs that derive from the sensitivity of cost-effective control strategies to climatological variability. 13 references, 2 figures, 4 tables.

38836 Measurement of fugitive atmospheric emissions of polychlorinated biphenyls from hazardous waste landfills. Lewis, R.G.; Martin, B.E.; Sgontz, D.L.; Howes, J.E. Jr. (Environmental Protection Agency, Research Triangle Park, NC). *Environmental Science and Technology;* **19**: No. 10, 986-991(Oct 1985).

Four landfills known to contain large quantities of polychlorinated biphenyls (PCBs) were monitored for atmospheric emissions: three of these were uncontrolled and contained large num-

bers of electrical capacitors, many of which were scattered on the surface and leaking PCB askarel fluids. The other is a state-of-the-art PCB waste landfill designed to exceed the requirements of the Toxic Substances Control Act of 1978 (ToSCA) for PCB disposal. Both high-volume and low-volume air sampling equipment were utilized at each landfill to monitor air levels of PCBs on site, upwind and downwind. In addition, vent ports were monitored at the controlled site. Simultaneous, collocated sampling was performed for quality assurance purposes and to obtain information on sampling performance and comparability. High atmospheric PCB concentrations were measured at the uncontrolled sites, while air levels were at or near background at the ToSCA-designed landfill. PCBs were detected at low levels in gas vents at the latter site.

38837 **Organic emissions from shale oil wastewaters and their implications for air quality.** Hawthorne, S.B.; Sievers, R.E.; Barkley, R.M. (Univ. of Colorado, Boulder). *Environmental Science and Technology;* **19**: No. 10, 992-997(Oct 1985). Contract AC02-83ER60121.

The emission of organic compounds from shale oil wastewaters used to cool hot, retorted, spent oil shale and for co-disposal with retorted shale was investigated. The major classes of compounds emitted are aromatic nitrogen-containing compounds, ketones, phenols, and nitriles, the same as those previously reported to be emitted from wastewaters exposed to air at room temperature. A gas-stripping method was modified to allow the determination of several Henry's law constants simultaneously. Measured values of H for these solutes in the wastewaters (10^{-4}-10^{-8} atm m_3 mol^{-1}) generally agreed with values determined for solutes in pure water, indicating that the wastewater matrix has little effect on H. Air samples collected in regions likely to be affected by atmospheric emissions from the shale oil industry had no detectable levels of the major organic species that are emitted from shale oil wastewaters, indicating that these species may be useful in tracing pollutant air masses resulting from shale oil production.

38838 **Development of a dosimeter for personnel exposure to vapors of polyaromatic pollutants.** Vo-Dinh, T. (Oak Ridge National Lab., TN). *Environmental Science and Technology;* **19**: No. 10, 997-1003(Oct 1985). Contract AC05-84OR21400.

A new personnel dosimeter based on molecular diffusion and direct detection by room temperature phosphorescence (RTP) has been developed to monitor vapors of polynuclear aromatic (PNA) pollutants. The dosimeter is a simple, pen-size device that requires no sample extraction for analysis. By proper calibration of the dosimeters, the time-weighted average exposure to the pollutants can be determined directly on the sample collection substrate. The dosimeters can detect a variety of PNA compounds such as pyrene, phenanthrene, and quinoline at 2.5, 0.5 and 0.75 ppb vapor concentrations, respectively, after 1 h of exposure.

38839 **Photolysis of polycyclic aromatic hydrocarbons adsorbed on simulated atmospheric particulates.** Behymer, T.D.; Hites, R.A. (Indiana Univ., Bloomington). *Environmental Science and Technology;* **19**: No. 10, 1004-1006(Oct 1985).

Fifteen polycyclic aromatic hydrocarbons (PAH) adsorbed on silica gel, alumina, fly ash, and carbon black were photolyzed in order to study their atmospheric fate. Photolytic half-lives for these particle-bound PAH were found to be highly dependent on the substrate to which they were adsorbed. On silica gel and alumina, PAH showed a wide range of photolytic half-lives, indicating a relationship between structure and photochemical reactivity. However, PAH on environmental substrates such as fly ash and carbon black show similar half-lives for most PAH, indicating a photolytic process that is independent of structure and dependent on the physical and chemical nature of the substrate. In fact, fly ash and carbon black appear to stabilize some PAH; this would facilitate their transport from combustion sources through the atmosphere.

38840 **(ESA-TT—24) DFVLR measuring system for the determination of the spatial distribution of environmental parameters of the atmosphere by means of mobile instrumented platforms.** Paffrath, D. (European Space Agency, 75 - Paris (France)). Aug 1985. Translated from DFVLR-Messsystem zur Erfassung der raeumlichen Verteilung von Umweltparametern in der Atmosphaere mit mobilen Messtraegern, DFVLR-FB—85-09, Oberpfaffenhofen, West Germany, (Dec 1984). (DFVLR-FB—85-09). 73p. NTIS, PC A05/MF A01; original German version available from DFVLR, Cologne DM 21.

Mobile measuring platforms and measurement methods for the quantitative determination of the spatial distribution of air pollution concentration and of meteorological parameters are described. The measuring instruments are installed in a twin-engined airplane for environmental research, in three vector gliders for acquisition of meteorological parameters, in a van for measuring aerosol and air pollution, and in a lidar system container for determination of the horizontal and vertical aerosol distribution.

38841 **Methods of depiciting the particle size properties of aerosols and powders.** Knutson, E. (U.S. Dept. of Energy, 376 Hudson Street, New York, NY 10014). pp 23.7 of Proceedings of the international symposium workshop on particulate and multi-phase processes. Ariman, T.; Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1985). (CONF-850406—).

From International symposium and workshop on particulate and multi-phase processes and the 16th annual meeting of the Fine Particle Society; Miami Beach, FL, USA (22 Apr 1985).

Two quantities-particle size and particle amount - are needed to fully describe the particle size properties of an aerosol or powder. By particle size we mean a quantity, concept or rule which allows us to assign a unique number (related to size) to each particle in a collection of particles. An optical or electron microscope, along with a rule such as measuring the largest linear dimension of each particle, is one acceptable method. There are many alternative methods each of which assigns a size (or size bracket) to individual particles; each yields a different definition of particle size. Particle amount is a quantity used to express the amount of substance in a given collection of particles. Taking the cascade impactor as an example, the particles in each size category can, among other things, be 1) counted, 2) weighed, 3) analyzed for radioactivity. These three methods yield three different, but equally valid, measures of particle amount. The intended use of the data will dictate which measure is most appropriate. The presentation defines particle size and particle amount in more detail and discusses the relative importance of the various measures of each quantity.

38842 **Particulate entrainment by wind.** Iversen, J.D. (Iowa State Univ., IA). pp 63.7-63.10 of Proceedings of the international symposium workshop on particulate and multi-phase processes. Ariman, T.; Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1985). (CONF-850406—).

From International symposium and workshop on particulate and multi-phase processes and the 16th annual meeting of the Fine Particle Society; Miami Beach, FL, USA (22 Apr 1985).

The prediction of the entrainment of particulate material by wind blowing over the material is difficult enough for sand-size particles (0.0625 to 2mm.) but prediction is still more uncertain for smaller particles (dust). As Bagnold (1960) states, the question "'at what winds speed will a dust deposit of specified particle size begin to be re-entrained?' cannot be given any (specific) answer. — The air flow needs to be defined in such a way as to enable an estimate to be made of the maximum fluid impulse likely to be received by the least secure of the exposed grains." The cohesive forces between very small particles are large enough that the so-called threshold speed for such small particles can be significantly higher than for larger particles. If the particle bed surface is not perfectly smooth, however, some particles may move at a lower speed than would be otherwise expected. Usually, for very small particles, if the wind speed is raised above threshold, then lowered, then raised again, the threshold speed will be higher the second time because the particle bed has become "more streamlined", and thus less sus-

ceptible to wind erosion. Once the particles are entrained, the prediction of the mass rate of entrainment is also uncertain.

38843 **Measurement of explosively generated aerosols in high energy environments.** Sandoval, R.P.; Newton, G.J. (Sandia National Labs., P.O. Box 5800, Albuquerque, NM 87185). pp 66.8 of Proceedings of the international symposium workshop on particulate and multi-phase processes. Ariman, T.; Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1985). (CONF-850406—). Contract AC04-76DP00789.

From International symposium and workshop on particulate and multi-phase processes and the 16th annual meeting of the Fine Particle Society; Miami Beach, FL, USA (22 Apr 1985).

Measurement of heavy-metal particle behavior and characteristics in explosive environments is a challenge to state-of-the-art methods in particle sampling, because it requires a sampling system capable of withstanding the shock and high temperature environment of the blast and the high velocity shrapnel produced from the explosion. In this paper, we report on an aerosol sampling package designed and built to measure explosively produced particles and to withstand the high pressures, temperatures, and shrapnel produced from detonation of a high explosive device. These sampling packages have been successfully used in several safety tests to sample explosively generated uranium aerosols in high energy environments. The sampling package is capable of providing data on airborne particle mass, size distribution, and particle morphology of the explosively produced aerosols and a record of the ambient pressure and temperature. A detailed description of the sampling package is presented along with performance results from safety tests in which the package was used to quantify and characterize the explosively produced heavy-metal aerosols.

38844 **Wind and saltation driven particle resuspension in a wind tunnel.** Fairchild, C.I.; Tillery, M.I.; Wheat, L.D.; Redmond, D.J. (Los Alamos National Lab., Los Alamos, NM 87545). pp 6311-6314 of Proceedings of the international symposium workshop on particulate and multi-phase processes. Ariman, T.; Veziroglu, T.N. Coral Gables, FL; Clean Energy Research Institute (1985). (CONF-850406—).

From International symposium and workshop on particulate and multi-phase processes and the 16th annual meeting of the Fine Particle Society; Miami Beach, FL, USA (22 Apr 1985).

To determine parameters of primary importance in wind and saltation driven resuspension of fine particles from surfaces, wind tunnel experiments were conducted to study resuspension of small polydisperse particles (diameter < 10 μm) by monodisperse saltation particles (diameter >80 μm). The experiments were designed to simulate the atmospheric boundary layer resuspension of fine particles. Wind Tunnel. The tunnel, fabricated of 3 m long aluminum alloy sections, had a rectangular cross section with a hydraulic diameter of 60 cm and was 40 m long. The resuspension bed, which was contained in one 3-m tunnel section, was 2-m in length by 15-cm wide, located symmetrically along the center line of the tunnel floor. Sufficient upstream tunnel length was employed to allow the natural formation of a fully turbulent boundary layer and velocity profile before the airstream passed over the resuspension bed.

38845 **Analysis of recent sulfur wet deposition and SO_2 emissions trends in Eastern North America.** Dittenhoefer; Ferullo, A.F. (Enviroplan, Inc., West Orange, NJ). *Proceedings, Annual Meeting, Air Pollution Control Association;* **1**: 1-16(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

This study applies some of the statistical techniques used by F.W. Lipfert et al. to 1977-1983 MAP3S precipitation chemistry data and to an SO_2 emissions database consisting of monthly SO_2 emissions from each U.S. electric utility, annual U.S. non-utility SO_2 emissions, and monthly and annual Canadian SO_2 emissions. The purpose of this study is to investigate the relative importance of meteorological versus SO_2 emissions variables with respect to precipitation sulfate concentrations, to examine the relative importance of local versus distant SO_2 source regions on sulfate concentration, and to estimate the degree of linearity between regional SO_2 emissions and sulfate deposition in the northeastern U.S.

38846 **Spatial trend analysis and uncertainty estimates of acid precipitation data in Ontario.** Tang, A.J.S.; Chan, W.H. (Ontario Ministry of the Environment, Toronto, Ontario). *Proceedings, Annual Meeting, Air Pollution Control Association;* **1**: 1-30(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

The use of the Simple Kriging and Universal Kriging methods to estimate the spatial trend in the spatial data is examined. By following the approach of the Simple Kriging methods, a new Modified Kriging method has been developed for better presentation of the spatial pattern of spatial data and error estimation. Results of comparison indicate that the Modified Simple Kriging method can provide better interpolation and error estimation for the mathematical functions. Although the results of practical interpolation obtained by using the three methods are quite comparable, the error estimates by the Simple Kriging and Universal Kriging methods are greater than those of the modified Simple Kriging method and the one standard deviation confidence belts are overlapping each other. This may indicate that the error estimations from the Simple Kriging methods are too great.The Universal Kriging method provides the greatest error estimation among these three methods. Although those results indicate that there is no advantages of using the Universal Kriging method, further study on the proper formula for the generalized covariance function should be carried out. The heart of the Universal Kriging method is to find the correct covariance function, since the isopleths and the error of estimation are very sensitive to it.

38847 **Dry deposition to snow in an urban area.** Dasch, J.M.; Cadle, S.H. (General Motors Research Laboratories, Warren, MI). *Proceedings, Annual Meeting, Air Pollution Control Association;* **1**: 1-15(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

Wet and dry deposition were measured in Warren MI during the 1983-1984 winter. Dry deposition was measured to a snow surface in a cutoff bucket and from the increase in snow core concentrations with time. The deposition velocity was calculated from the ratio of the dry flux to the ambient concentration. The dry deposition velocities calculated to a snow surface were 0.082 cm/s for SO_2, 2.0 for HNO_3, 0.083 for NH_4^+, 2.0 for CA^{++} and 4.3 for Cl. The values were not significantly different for a snow/water surface during melting compared to a snow surface. However, higher values of 0.69 cm/s for SO_2, 6.2 for HNO_3, 0.33 for NH_4^+, and 4.2 for Ca^{++} were found to a deionized water suface in the spring. The higher values could be due to the higher air temperature and a change from a solid to a liquid surface or to greater atmospheric mixing during this period. The relative importance of wet and dry deposition was examined during the snow cover period of December 18 to March 14. Dry deposition was very important accounting for 42-80% of the total flux of the major ions. This was due both to the low precipitation volumes in the winter and the influence of local sources on dry deposition. Dry deposition increased the importance of sulfate relative to nitrate in the snowpack.

38848 **Analysis of wet deposition at an urban location.** Foltman, R.A. (Detroit Edison Co., Detroit, MI). *Proceedings, Annual Meeting, Air Pollution Control Association;* **1**: 1-13(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

Wet deposition data collected at the Detroit Edison urban site provided a clear chemical profile at this location for the period studied. Correlations of major anions with acidity indicate that decreases in pH are associated with increases in sulfates and nitrates. However, other components not measured may have a bearing on pH reductions. The differences between two locations 70 km apart were quite small on the average. Strong local source influences at the urban location were not evident in the limited data set available for study. Wind direction can help determine the ultimate origins of pollutants.

38849 Meso - and synoptic-scale pollutant transport: Review of episode formation and transport meteorology, methods of analysis, and anatomy. Lazaro, M.A. (Argonne National Laboratory, Argonne, IL). *Proceedings, Annual Meeting, Air Pollution Control Association;* 1: 1-19(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

This paper reviews and summarizes the meso- and synoptic-scale pollutant phenomena and the types of meteorological conditions that are associated with the formation of persistent elevated pollution episodes. Various types of wet and dry mesosynoptics conducive to such episodes are identified and reviewed. The importance of gaining a better understanding of how various complex meso-and synoptic-scale systems act to vent pollutants through the top of the planetary boundary layer(PBLO, redistribute pollutants within the PBL, and remove pollutants at the surface is underscored. The status of development, strengths, and weaknesses of four major sourcereceptor analysis approaches are discussed. Eastern North American air-pollution episodes noted in the literature are high-lighted, and the anatomy of two episodes is presented.

38850 Comparison of chemical mechanisms for regional acid deposition. Stockwell, W.R. (National Center for Atmospheric Research, Boulder, CO). *Proceedings, Annual Meeting, Air Pollution Control Association;* 1: 1-11(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

The purpose of this paper is to describe a state-of-the-art gas phase chemical mechanism for use in the EPA/NCAR regional acid deposition model (RADM). The Eulerian regional acid deposition model under development at the National Center for Atmospheric Research will require on the order of tens of thousands of grid cells. The gas phase chemical mechanism must have enough chemical detail to give accurate oxidation rates of sulfur dioxide and nitrogen species. It is also important for the mechanism to give accurate production rates of those species such as hydrogen peroxide, organic peroxides and ozone which are necessary for the oxidation of sulfur dioxide in liquid phase. The mechanism must provide this high level of chemical realism while using a minimum of chemical detail.

38851 Analysis of the environmental need for NO/sub x/ controls on light duty trucks and heavy duty vehicles. Gutfreund; Burton, C.S.; Oliver, W.R.; Haney, J.L.; Hogo, H.; Seigneur, C. (Systems Applications, Inc., San Rafael, CA). *Proceedings, Annual Meeting, Air Pollution Control Association;* 3: vp(1985). (CONF-850612—).

From Air Pollution Control Association annual meeting and exhibition; Detroit, MI, USA (16 Jun 1985).

The paper reports on an ongoing study to evaluate the environmental need for postulated NO/sub x/ controls of heavy duty vehicles, i.e., light duty trucks, and heavy duty trucks (gasoline and diesel fueled), in selected cities where ozone levels exceed the NAAQS and NO_2 levels approach the NAAQS. The study involves the use of the most advanced modeling techniques and comprehensive data bases commensurate with the requirements of the models to investigate the influence of postulated NO/sub x/ controls on annual average NO_2 levels, 1-hour maximum urban ozone levels, 1-hour maximum rural ozone levels, and 1-hour maximum urban NO_2 levels, in 1995 and 2000. The Urban Airshed Model (UAM) is being used to characterize NO/sub x/ control effects on 1-hour maximum ozone concentrations and on 1-hour maximum NO_2 concentrations, in cities where available aerometric data bases for its use exist. Annual average NO_2 levels are being projected with the Climatological Dispersiom Model (CDM), in cities where available emission inventories are compatible with the requirements of CDM. Effects of NO/sub x/ controls on maximum 1-hour rural ozone levels are being projected by means of a trajectory box mode.

38852 Effect of mass transport on the determination of corrosion rates from polarization measurements. Nagy, Z.; Thomas, D.A. (Argonne National Lab., Argonne, IL). pp 230-231 of Proceedings of the fall 1985 meeting of the Electrochemical Society. Pennington, NJ; Electrochemical Society (1985). (CONF-851048—).

From 168. meeting of the Electrochemical Society; Las Vegas, NV, USA (13 Oct 1985).

Many methods have been proposed for the determination of the corrosion current density from polarization curves; the two most commonly used ones are the three-point method and the curve-fitting method. The basis of these methods is a polarization equation that (i) was derived for the complete absence of mass-transport effects or (ii) considers the cathodic partial reaction to be under complete mass-transport control. The mixed control case has been investigated much less often, even though this case may quite frequently reflect practical situations. A completely generalized polarization equation is proposed that can be used as a basis for curve-fitting data evaluation under any conditions. This equation was used to determine thé error caused by the neglect of mass transport effects in conventional data analysis.

5003 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 37545, 37548, 37556, 37560, 37613, 37633, 37641, 37660

38853 (ORNL/M—135) Historical releases of radioactivity to the environment from ORNL. Ohnesorge, W.F. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 37p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011372.

This report gives a brief history and assessment of ORNL radionuclide releases to the environment. A short history and an inventory of radioactivity disposed of by shallow land burial and hydrofracture techniques are given along with a brief discussion of the potential environmental impact of these disposed materials. The data available for this report varied greatly in quality. Data on contaminated liquid waste and liquids discharged to the environment are much more reliable than early data on contaminated air discharges and contaminated solid waste. Data for more recent years are more complete and reliable than data obtained from records dating back to the early history of the laboratory. The data presented here do not include materials retrievably stored (with the exception of uranium solid waste data) or inventories of materials stored in operating or surplus facilities since these materials presently have no contact with or loss to the environment.

38854 (SAND—86-0865C) Prediction of radiological dispersal from sabotage incidents involving high explosive. Boughton, B.A. (Sandia National Labs., Albuquerque, NM (USA)). 22 Jun 1986. Contract AC04-76DP00789. 10p. (CONF-860654—5). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011829.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

The intentional dispersal of radioactive material from a nuclear facility by use of explosive can result in severe radiological consequences. In many situations, it is important to be able to predict the magnitude and direction of this dispersal for: (a) evacuation and sheltering decisions; and (b) to estimate the potential size of the cleanup operation. Most commonly used predictive methods do not trace the cloud trajectory through its rise to a thermally-equilibrated height but, instead, assume a stabilized height and map the dispersal from this origin. A calculational method which more realistically describes this close-in behavior has been developed. This procedure predicts the cloud height as a function of downwind distance and existing meteorological conditions. Comparisons of these predictions with experimental data will be presented. In addition, the model provides estimates of downwind ground deposition and dose to exposed personnel. The results of these predictions are also presented.

38855 Distribution of cosmogenic ^{7}Be in salt marsh sediments. Casey, W.H.; Larsen, I.L.; Olsen, C.R. (Department of Geosciences, The Pennsylvania State University). *Geophysical Research Letters;* 13: No. 4, 322-325(Apr 1986).

Two related factors affect the vertical distribution and inventory of ^{7}Be (53-day half life) in salt marsh sediments: (1) the movement of pore water, and (II) the vegetation. Infiltration of rainwater into unsaturated sediment distributes ^{7}Be over several centimeters depth without disturbing the sediment fabric. The sediment inventory of ^{7}Be expected from its atmospheric flux could only be accounted for in vegetated areas where foliage traps ^{7}Be from rainfall and surface flow. These factors lead to hetero-geneous vertical and lateral distributions of ^{7}Be throughout the marsh, and may also affect the sediment distribution of the other trace substances, such as ^{210}Pb, ^{137}Cs, and heavy metals.

38856 Radiation measurements in a labyrinth penetration at a high-energy proton accelerator. Cossairt, J.D.; Couch, J.G.; Elwyn, A.J.; Freeman, W.S. *Health Physics;* No. 5, 907-917(Nov 1985).

The efficient design of access penetrations at high-energy proton accelerators is desirable for both economic and personnel protection reasons. This paper reports on a series of measurements made in a personnel access labyrinth which viewed an Al target bombarded by 400-GeV protons from the Fermilab Tevatron. Measurements of absorbed dose in the labyrinth using tissue-equivalent ion chambers were consistent with theoretical predictions of both the relative attenuation through the penetration and the absolute magnitude near the target. The multisphere technique was used to determine the neutron energy spectrum in one section of the labyrinth. A recombination chamber was used to measure the quality factor of the radiation field in two sections of the labyrinth. Good agreement with the quality factor deduced from the multisphere result was obtained at the same measurement location.

5006 Regulations

REFER ALSO TO CITATION(S) 37470, 38076, 38087, 38096, 38851

38857 (ANL/EES-TM—307) Analysis of inhalable and fine particulate data and evaluation of their prediction models. Chun, K.C.; Fingleton, D.J. (Argonne National Lab., IL (USA)). Mar 1984. Contract W-31-109-ENG-38. 54p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012219.

In anticipation of size-specific ambient particulate air quality standards, the US Environmental Protection Agency has established an inhalable particulate matter monitoring network on a limited scale. Simple arithmetic average ratio models for predicting inhalable particulate levels have been previously derived by others based on the inhalable particulate concentration data and colocated high-volume sampler data obtained from the monitoring network. In order to improve such models for predicting various size-specific particulate concentration levels from an expanded data base, this report: (1) describes procedures for improved data screening and for calculation of concentrations for particles with aerodynamic diameters less than 10 μm, (2) tests whether the predictive ability of simple arithmetic average ratios can be improved by data stratification by key parameters, and (3) assesses the likelihood of nonattainment at the county level with respect to potential size-specific ambient particulate standards. Seasonal and regional characteristics of various size-specific and total suspended particulate concentration levels are also described.

38858 (UCRL—92534) Bhopal: lessons learned. Greenly, G.D. Jr. (Lawrence Livermore National Lab., CA (USA)). Mar 1986. Contract W-7405-ENG-48. 3p. (CONF-860803—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010977.

From 7. world clean air congress and exhibition; Sydney, Australia (25 Aug 1986).

The risk assessment lesson learned from the Bhopal tragedy is both simple and complex. Practical planning for toxic material releases must start with an understanding of what the risks and possible consequences are. Additionally, plans must be formulated to ensure immediate decisive actions tailored to site specific scenarios, and the possible impacts projected on both the plant and surrounding communities. Most importantly, the planning process must include the communities that could be affected. Such planning will ultimately provide significant financial savings and provide for good public relations, and this makes good business sense in both developed and developing countries. Paraphrasing the adage "a penny saved is a penny earned," a penny spent on emergency preparedness is dollars earned through public awareness. The complex aspect of these simple concepts is overcoming human inertia, i.e., overcoming the "it can't happen here" syndrome in both government and private industry. A world center of excellence (ITRAC), acting as a center for education, research, and development in the area of emergency planning and response, will be the conduit for needed technology transfer to national centers of excellence in emergency planning and response. These national emergency planning and response centers (NARACS), managed by private industry for governments, will be catalysts to action in formulating effective plans involving potentially affected communities and plant management. The ITRAC/NARAC proposal is a simple concept involving complex ideas to solve the simple problem of being prepared for the Bhopal-like emergency which, as experience has demonstrated, will have complex consequences for the unprepared.

51 ENVIRONMENTAL SCIENCES, TERRESTRIAL

5101 Basic Studies

REFER ALSO TO CITATION(S) 37286, 38098, 38881

38859 (DOE/NBB—0078) Comparison of tropical forest surveys. Molofsky, J.; Hall, C.A.S.; Myers, N. (Butler Univ., Indianapolis, IN (USA). Holcomb Research Inst.; Cornell Univ., Ithaca, NY (USA); Myers (Norman), Oxford (UK)). Jun 1986. Contract AC05-84OR21400. 70p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86011699.

This report examines the two most recent studies of tropical forest areas and rates of forest loss: Norman Myers' conversion of Tropical Moist Forests (1980), and the FAO/UNEP Tropical Forest Resources Assessment Project in order to identify and clarify discrepancies between them. The apparent discrepancy between their respective estimates of deforestation rates has been the basis of a continuing controversy. Myers' report was concerned principally with the conversion of virgin forests to other land use and the resulting extinction of tropical species. The FAO/UNEP report emphasized the availability of forest resources to meet the future fuelwood, housing, and economic needs of UN member states. The present paper attempts to identify more precisely the differences between the two studies in order to integrate the large tropical forest data base from these two sources into a cohesive whole. Specifically, we identify those countries covered in both surveys where the largest differences occur. Our study was not designed to assess all discrepancies between Myers and FAO but only the discrepancies for those countries where both investigators have given specific numbers.

38860 Immediate effects of prescribed burning on mineral soil nitrogen in ponderosa pine of New Mexico. Kovacic, D.A.; Swift, D.M.; Ellis, J.E.; Hakonson, T.E. (Colorado State Univ., Fort Collins). *Soil Science;* 141: No. 1, 71-76(Jan 1986). Contract AC09-76SR00819.

From American industrial hygiene conference; Dallas, TX, USA (18-23 May 1986).

Three 0.1-ha ponderosa pine (Pinus ponderosa Dougl. ex Laws) sites were burned in the fall of 1981. The burn was mainly a ground fire. Burn intensity was 980, 1760, and 2280 kJ s^{-1} m^{-1} on sites 1, 2, and 3, respectively. We analyzed the mineral soils on each of these sites for total N, NO_2^- + NO_3^--N and NH_4^+-N prior to prescribed burning, 1 d postburn, and 30 d postburn. On the most intense burn, NH_4^+-N levels increased threefold from preburn (10 ppm) to 1 d postburn (32 ppm), but declined somewhat 30 d following the burn (24 ppm). Concentrations of NO_2^- + NO_3^--N on site 3 rose from 1 ppm preburn and 1 d postburn to 5 ppm 30 d

postburn. There were no significant differences in soil total N after burning. Immediate postburn inorganic N values for ponderosa pine mineral soils have not been previously reported in the literature. It is important to investigate burned soils immediately after burning to better understand sequential processes involved in postfire inorganic N dynamics.

5102 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 37441, 37462, 37842, 37847, 38737, 38792, 38798, 38799, 38891, 38897, 38903

38861 (CONF-8604211—1) **Atmospheric deposition and cation leaching.** Harrison, R.B.; Johnson, D.W. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 32p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012238.

From Atmospheric deposition symposium; Little Rock, AR, USA (20 Apr 1986).

This paper reviews many of the important aspects of soil chemistry that play a role in the rates of soil acidification and contains comparisons of solution chemistry of two sites not subject to acidic precipitation (pH = 5.6) with seven sites that are (pH 4.8 to 4.0). The pH and concentrations of basic cations, aluminum, and anions were determined as precipitation moved through the forest canopy and percolated through the soil profile. Changes in solution chemistry reflect changes in soil chemistry and potential effects on exchangeable cations due to soil cation leaching.

38862 (EPRI-CS/EA/EL—4480, pp 4.17-4.20) **Comparison of PCB analytical methods.** Wong, L.W. (Pacific Gas and Electric Co., San Ramon, CA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Gas chromatography has been the accepted method for PCB analysis. Because of the labor involved, it is an expensive analysis. Several alternate methods are now available which are faster, portable, and less expensive. These methods have been evaluated and include the McGraw Edison specific ion electrode method, the CLOR-N-OIL colorimetric method, and the S-Cubed PCBA-102 gas chromatograph/computer. The PCPA-102 appears to be a logical choice as an analytical alternative to GC. The CLOR-N-OIL and McGraw Edison are better suited for screening samples for approximate PCB concentration.

38863 (EPRI-CS/EA/EL—4480, pp 4.21-4.41) **Development of the BPA substation soil PCB testing program.** Plath, D.C. (Bonneville Power Administration, Vancouver, WA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

In discussing The Bonneville Power Administration's PCB testing program, it is pointed out that setup of instrumentation to ensure airtight systems and extreme cleanliness is of vital importance. Quality assurance procedures are also critical to obtaining good results. Methodologies for the analysis of PCBs in substation soils are discussed, along with sampling plans for the analysis of PCBs. The problems and advantages of using contract labs in this sort of work are discussed. 6 references, 10 figures, 1 table.

38864 (EPRI-CS/EA/EL—4480, pp 4.42-4.43) **Analytical method for the analysis of chlorinated biphenyls in liquids and solids.** Erickson, M.D.; Stanley, J.S.; Turman, J.K.; Radolovich, G.; Heggem, D.T. (Midwest Research Institute, Kansas City, MO). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The use of the gas chromatograph/electron impact mass spectrometric (GC/EIMS) method yields qualitative information which not only readily differentiates among PCB homologs but also permits elimination of other compounds from quantitation. A variety of general and specific sample preparation options are presented. The method consists of the following steps: The process or product must be sampled such that the specimen collected for analysis is representative of the whole. The sample is mechanically homogenized and subsampled if necessary. The surrogate-spiked sample is extracted and cleaned up at the discretion of the analyst. The PCB content of the sample extract is determined. PCBs are identified by comparison of their retention time and mass spectral intensity ratios to those in calibration standards. PCBs are quantitated by the internal standard technique.

38865 (EPRI-CS/EA/EL—4480, pp 4.44-4.45) **Field measurement of PCB's in soil and sediment using a portable gas chromatograph.** Spittler, T.M. (Environmental Protection Agency, Lexington, MA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A field method for extraction and measurement of PCBs from soil and sediment which can be performed in as little as seven minutes after the sample is collected is discussed. The Model 511-06 gas chromatograph made by Analytical Instruments Development Company forms the basis of the technique. Field extraction techniques are discussed. The method has been applied in the field at several PCB spills and cleanup operations. Results of this work are discussed. Several samples have been analyzed by the field technique and the been subjected to standard laboratory PCB analytical procedures. Studies have also been carried out to determine the extraction efficiency of the field method on different Arochlors. Results of this work are discussed.

38866 (EPRI-CS/EA/EL—4480, pp 4.46-4.58) **Distribution of polychlorinated biphenyls within Bonneville Power Administration substation.** Baker, D.W. Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The Bonneville Power Administration (BPA) is a federal power distribution and marketing agency for some 30 hydroelectric dams in the Columbia River Basin. An analysis is presented of overall PCB soil contamination patterns within fenced BPA substations based on a continuing PCB study which is about one-third complete. Results are included on 13 substations identified for comprehensive sampling and the findings from these substations are reviewed in detail. Levels of soil contamination are considered in relation to the general equipment locations within the substations and maintenance history, in order to check basic assumptions used in developing reduced sampling plans. 3 figures, 3 tables.

38867 (EPRI-CS/EA/EL—4480, pp 5.1-5.5) **Pilot plant studies for solvent extraction of polychlorinated biphenyl (PCB) from soil.** Saunders, M.B. (Martin Marietta Energy Systems, Oak Ridge, TN). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Soilex is a process for a solvent removal of PCB from soils. A study was carried out to determine the importance of component (soil-water-kerosene) variables and mixing time. Soil-to-water ratios of 3 to 5 and soil-to-kerosene ratios of 3 to 5 are best. No difference in extraction performance could be determined between 15 and 30 minute mixing times. A pilot plant was operated for 19 days. A preliminary cost estimate of the entire solvent leach and PCB removal from soil process was completed. The solvent extraction process cost was about half of the direct incineration cost. 2 figures.

38868 (EPRI-CS/EA/EL—4480, pp 5.6-5.12) **Polychlorinated dibenzofuran contamination of the State Highway Department Office Building in Santa Fe, New Mexico as a result of a PCB transformer malfunction.** DeRoos, F.L.; Watson, S.C.; Hatchel, J.A. (Battelle Memorial Institute, Columbus, OH). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

On June 17, 1985, an electrical malfunction occurred in the New Mexico State Highway Department Office Building in Santa Fe, New Mexico. A transformer containing 245 gallons of askarel consisting of Aroclor 1260 and a mixture of tri- and tetrachlorinated benzenes overheated resulting in the release of vaporized askarel. The vapor was distributed throughout the building by convective air currents and by mechanical transfer via the heating, ventilation, and air conditioning systems. Air and surface wipe samples, as well as coolant fluid samples were collected within seven days of the malfunction. The total concentrations of polychlorinated dibenzofurans (PCDF) in the air ranged from approximately 10 to 500 pg/m^3. Polychlorinated dibenzo-p-dioxins (PCDD) were detected in the range of 7 to 21 pg/m^3. 4 figures.

38869 (EPRI-CS/EA/EL—4480, pp 5.13-5.16) **Development of a spray - vacuum head and support system for the removal of PCB contamination from walls, floors, and other surfaces.** Ashley, K.C. (Quadrex HPS, Inc., Gainesville, FL). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Early engineering work by Quadrex HPS addressed the unique problem of removal of plutonium waste materials which coated the interior surfaces of a glove-box type assembly chamber. A prototype surface-decontamination system was configured which consisted of a cleaning head and support system. The design and operation of the system are described. A research program is being carried out to modify this system for the fast and effective removal of PCB contamination. The overall program has been divided into a series of fact-finding and development steps with review and assessment occurring at key stages.

38870 (EPRI-CS/EA/EL—4480, pp 5.17-5.22) **Sorption/desorption of polychlorinated biphenyls in soils.** Girvin, D.C.; Sklarew, D.S.; Ainsworth, C.C. (Battelle, Pacific Northwest Labs., Richland, WA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The adequacy of currently available data and estimation techniques and models for describing PCB sorption/desorption in soil-water systems are summarized for both typical and low organic carbon soils. Deficiencies or gaps in available data and key unresolved issues are also discussed. Specifically, these areas are: Determination of K/sub p/ to K/sub ow/ correlation coefficients to enable use of extensive K/sub ow/ and other physical data for estimating of K/sub p/s; Determination of the reversibility and release rates of Aroclors from soils in aqueous systems; Sorption/desorption in low organic carbon soils, and; The influence of the surfactants on sorption/desorption and desorption release rates of Aroclors from soils for possible application in aqueous-based soil-washing technology. 15 references.

38871 (EPRI-CS/EA/EL—4480, pp 5.23-5.26) **Desorption of PCBs in a soil-aqueous solution system.** Essington, M.E.; Reaketo, M.R.; Cliath, M.M.; Elseewi, A.A.; Doyle, C.P. Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The partitioning of capacitor oil Aroclor 1242 between soil and aqueous equilibrium bathing solutions over a wide range of PCB concentrations was characterized. PCB behavior was examined as a function of homolog type and as a function of aqueous solution composition. Aroclor 1242 homolog retention was found to increase in the following order: DCB TCB TTCB, irrespective of solution composition. Solubilities and Freundlich parameters were affected by the composition of the equilibrating solution. The results obtained are expected to provide greater insight into the environmental behavior of the various PCB homologs and to provide usable data to predict the mobility of PCBs in environments exposed to accidental Aroclor spills. 11 references, 2 tables.

38872 (EPRI-CS/EA/EL—4480, pp 5.27-5.30) **Solvent cleaning of PCB - contaminated soils.** Weitzman, L. (Acurex Corp., Cincinnati, OH). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A pilot-scale study of a novel system for cleaning soils that have been contaminated with PCB is described. The design and operation of the equipment involved is discussed. The process concentrates the PCB extracted from soils and reclaims the solvents used. Final PCB concentrations of less than 2 ppm in the soil have been achieved. 1 figure, 1 table.

38873 (EPRI-CS/EA/EL—4480, pp 6.4-6.6) **Preventive measures for reduction of airborne PCB contamination risk.** West, B.W.; Hansen, W.G. (West & Hansen Engineers, Inc., Long Beach, CA). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Installation of risk reduction measures can rapidly and inexpensively lower the probability of extensive airborne PCB contamination. Maximizing the cost-effectiveness of this approach requires a well-planned survey program, including on-site investigations. In recognition of the need to assist member utilities conducting airborne PCB spill risk reduction programs, EPRI sponsored development of a design manual addressing technical, economic, and environmental aspects of preventive engineering. The design manual is organized into four sections presented sequentially in the order of their occurrence in a risk reduction program. These are: Ranking PCB installations on the basis of their potential for widespread contamination; Selecting the most appropriate spill reduction approach; Determining design requirements; and Preparing design plans and specifications.

38874 (EPRI-CS/EA/EL—4480, pp 6.23-6.25) **Occupational exposure of electric utility personnel to PCBs: a case study.** Sahl, J.D.; Crocker, T.T.; Saperstein, M.D.; Faeder, E.J. (Southern California Edison Co., Rosemead). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

A research project was developed to determine the occupational exposure to PCBs of Southern California Edison Company personnel. Levels of PCB in blood were compared from several exposure categories, and the amount of PCB in electrical apparatus in the Edison system was measured. To establish a background blood PCB level for non-occupationally exposed individuals, blood samples from the pre-employment medical examinations of 738 new employees were analyzed for PCB. Blood PCB levels of 1058 current personnel have a median of 3 ppb with a mean of 4 (SD=4) ppb. There is no significant difference in blood PCB concentration between the pre-employment, current employment, and the subset of high exposure potential groups. There is no indication that a blood concentration at these levels poses a threat to human health. These data indicate that no significant occupational exposure to PCBs has occurred among personnel of this utility, and that no significant health impacts would be expected from PCBs.

38875 (EPRI-CS/EA/EL—4480, pp 7.1-7.6) **Measurement of PCDF and PCDD in utility equipment.** Gordon, S.H., Miller, M.; DeRoos, F.L.; Cooke, M.; Guertin, J.; Addis, G. (IIT Research Institute, Chicago, IL). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

At the temperatures that prevail in transformer fires, PCB may react to form PCDF and other toxic oxidation products. Information is sparse, however, on the distribution of PCDF and PCDD in PCB-containing insulation fluids used by the electric utility industry. The Electric Power Research Institute (EPRI) recently initiated a program to evaluate and develop compound-specific analytical procedures for characterizing PCDF and PCDD in PCB-containing insulation fluids. The EPRI-sponsored research has three basic goals: To improve the chemical analytical methods for individual compounds of PCDF and PCDD; to determine the concentration of PCDF and PCDD in utility equipment that has seen varied use; and to develop a screening test that determines PCDF and PCDD concentrations rapidly in order to reduce costs and time delays before undertaking cleanup activities after PCB fires. The chemical analytical methods used and some of the early results of these studies are summarized. 3 tables.

38876 (EPRI-CS/EA/EL—4480, pp 7.11-7.19) **Safety of non-PCB reclassified transformers in fire incidents a building scale engineering study.** Cooke, M.; DeRoos, F.L.; Rising, B.; Martin, W.H. (Battelle Memorial Institute, Columbus, OH). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

Battelle's Columbus Laboratories, under contract to Union Carbide, designed and built a pilot scale combustion apparatus which could simulate the conditions existing in an accidental building fire. The materials tested in this study duplicated the coolant from an askarel transformer which had been serviced with TF-1 to remove PCB and subsequently refilled with silicone. The results of the study revealed no measurable PCDD production and only traces of PCDF. It is apparent from these data that Arochlor 1260 produces the highest relative levels of PCDF which is expected due to the higher level of chlorination in Aroclor 1260 as versus 1254. Aroclor 1242 which has the lowest chlorine content also produces the lowest chlorine content also produces the lowest PCDF levels. In all cases the amounts of PCDF produced were below one ppb. 2 references, 4 tables.

38877 (EPRI-CS/EA/EL—4480, pp 7.22-7.23) **PCB accident in France.** Rappe, C.; Kjeller, L.O.; Marklund, S.; Nygren, M.; Fournie, R. (Univ. of Umea, Sweden). Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

In the evening of January 14, 1985, an explosion followed by a fire ruptured a transformer in the basement of a residential building in Reims, France. The dielectric fluid in the transformer consisted of a mixture of PCB (60%) and trichlorobenzene (TCB) (40%). Two days after the accident dielectric fluid collected near the transformer and soot samples were analyzed. PCDFs and TCDDs were not present. A series of PCDFs have been found in samples collected in other parts of the building. Variability in measured levels indicates the need for more accurate analytical procedures. 1 figure, 2 tables.

38878 **(EPRI-EA—4544) Geochemical behavior of chromium species.** Rai, D.; Zachara, J.M. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 217p. NTIS, PC A10/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; GPO Dep. File Number DE86011642.

The reactions studied were: (1) the hydrolysis constants for Cr(III) and the solubilities of $Cr(OH)_3(s)$ and Cr/sub x/Fe/sub 1-x/$(OH)_3(ss)$, (2) the oxidation of aqueous Cr(III) to Cr(VI) by manganese dioxide, and (3) the adsorption of aqueous Cr(VI) by iron oxides. Based on the solubility of $Cr(OH)_3$ as a function of pH, hydrolysis constants were determined for the formation of $CrOH^{2+}$, $Cr(OH)_3^0$, and $Cr(OH)_4^-$, which are dominant aqueous species in different pH regions. The solubilities of $Cr(OH)_3$ and Cr/sub x/Fe/sub 1-x/$(OH)_3$ from both the oversaturation and undersaturation directions show that the equilibrium is reached in <67 days and that the kinetics of precipitation/dissolution of these solids is relatively fast. Because $Cr(OH)_3$ and Cr/sub x/Fe/sub 1-x/$(OH)_3$ precipitate rapidly, have low solubilities, and can form under geologic conditions, their solubilities can be used to set upper limits on Cr(III) concentrations in geologic systems. Manganese dioxide oxidized aqueous Cr(III) to Cr(VI) in a pH range of 3.0 to 10.3. The rates of Cr(III) oxidation in acidic solutions (pH 3.0 to 4.7) are relatively more rapid and are primarily dependent on the MnO_2 surface area and the ratio of Cr(III) to Cr(VI) in solution. Mechanistic constants were developed for the adsorption of CrO_4^{2-}, $H_2CO_3^0/HCO_3^-/CO_3^{2-}$, SO_4^{2-}, and Ca^{2+} on amorphous and crystalline iron oxides.

38879 **(EPRI-EA—4607) Remote sensing to detect ecological impacts associated with acid deposition. Final report.** Van Voris, P.; Wukelic, G.E. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 67p. NTIS, PC A04/MF A01; 1 - Research Reports Center, Box 50490, Palo Alto, CA 94303; GPO Dep. File Number DE86011649.

A planning study was conducted to determine the potential applications of remote sensing for detecting ecological impacts that have been reportedly caused by acid deposition. The project was divided into two phases: a technology assessment phase (Phase I) and a prototype demonstration (Phase II). The emphasis of the project was on detecting ecological change, not on determining the cause of that change. The latter is the role of ground-based research. Phase I consisted of an assessment of terrestrial and aquatic components that are indicative of sensitivity to acid deposition. The assessment identified remote sensing as the optimal cost-effective method for measuring the rate of change of land use, crop type, and forest canopy health over large geographic areas. In Phase II, spectral reflectance in the near-infrared region of the spectrum from forest canopies of Camel's Hump State Forest from two Landsat scenes from the summers of 1976 and 1983 were compared. Significant increases in spectral reflectance from the forest were detected when the pixels were compared, and it is hypothesized that this increase is indicative of a decline in forest growth and canopy closure. However, because of project limitations, no ground-truth data were collected by Battelle-Northwest scientists to verify the findings of the remote sensing analyses. A comprehensive research program is recommended to further investigate the use of remote sensing to detect ecological damage and its relationship to possible causative agents. Future research should also focus on the use of remote sensing for identifying ecosystems that may be sensitive to perturbations like acid deposition and improving our ability to model ecological processes. Priority should be given to detecting, monitoring, and modeling changes in forested watersheds.

38880 **Quinoline sorption to subsurface materials: role of pH and retention of the organic cation.** Zachara, J.M.; Ainsworth, C.C.; Felice, L.J.; Resch, C.T. (Pacific Northwest Lab., Richland, WA). *Environmental Science and Technology;* 20: No. 6, 620-627(Jun 1986). Contract AC06-76RL01830.

The sorption of quinoline (pK/sub a/ = 4.94) was investigated on low-organic-carbon subsurface materials that varied in pH. Sorption isotherms were measured from 10^{-7} to 10^{-4} M quinoline and were found to be nonlinear. The resulting Freundlich constant (K/sub F/), based on total aqueous quinoline concentration, were poorly correlated with subsoil properties, including organic carbon. Higher sorption in the acidic subsoils and favorable coefficients for regression of K/sub F/, normalized to cation-exchange capacity vs. the ionization fraction (Q), point to the importance of ion exchange of the protonated compound. When the subsoil pH is adjusted, it is shown that sorption parallels the ionization fraction and retention of the organic cation far exceeds that of the neutral species. Calculations of surface speciation and thermodynamic parameters of sorption (ΔH°, ΔS°) point to ion exchange and/or surface protonation at pH, levels exceeding pK/sub a/ by greater than 2 log units. It is suggested that in subsurface materials of low carbon content,

quinoline sorption is controlled by pH the nature and capacity of the exchange complex, and groundwater ion composition. 46 references, 5 figures, 4 tables.

5103 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 37464, 37541, 37560, 37584, 37586, 37588, 37593, 37639, 37641, 37660, 38911, 38951

38881 (INIS-mf—9887) Investigations of gas/water interactions in unsaturated soil using CO_2 and ^{222}Rn measurements. Doerr, H. (Heidelberg Univ. (Germany, F.R.). Naturwissenschaftlich-Mathematische Gesamtfakultaet). 1984. 99p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752080.

Using the example of the unsaturated soil and groundwater around the Sandhausen measuring point, the interdependence between the isotope composition of the different components in the various ground reservoirs was illustrated. The measured values are compatible with model calculations of carbon and carbon isotope transport and exchange in the unsaturated soil; this suggests that the model assumptions may be applicable to other sites. (orig./HP).

38882 (UCID—20267) Rancho Seco liquid effluent pathway aquatic and terrestrial dietary survey report. Eagle, R.J.; Wong, K.M.; Noshkin, V.E. (Lawrence Livermore National Lab., CA (USA)). 30 Nov 1984. Contract W-7405-ENG-48. 40p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011010.

This report is a detailed summary of a survey conducted to identify all environmental pathways that may lead to any potential radiological dose to individuals utilizing aquatic and terrestrial components possibly contaminated with radionuclides contained in the liquid effluents that have been routinely discharged since 1980 to Clay Creek from the Rancho Seco Nuclear Generating Station. All land users and identified residents who obtain food from the creeks or use the creek water for irrigation or recreation were interviewed. Site specific usage parameters for the consumption of different food products and for direct exposure to individuals at downstream locations were identified and are discussed in this report. These usage parameters will be used with appropriate radionuclide concentration data to estimate radiological dose to man from the identified liquid effluent pathways.

38883 Environmental applications for an intrinsic germanium well detector. Stegnar, P.; Eldridge, J.S.; Teasley, N.A.; Oakes, T.W. (Oak Ridge National Lab., Oak Ridge, TN 37831). pp 313-318 of Analytical spectroscopy. Lyon, W.S. New York, NY; Elsevier (1984). (CONF-831025—).

From 26. ORNL-DOE conference on analytical chemistry in energy technology; Knoxville, TN, USA (11 Oct 1983).

The overall performance of an intrinsic germanium well detector for ^{125}I measurements was investigated in a program of environmental surveillance. Concentrations of ^{129}I and ^{131}I were determined in thyroids of road-killed deer showing the highest activities of ^{125}I in the animals from the near vicinity of Oak Ridge National Laboratory. This demonstrates the utility of road-killed deer as a bioindicator for radioiodine around nuclear facilities.

5104 Thermal Effluents Monitoring And Transport

REFER ALSO TO CITATION(S) 38737

5105 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 37391, 37473, 38796

38884 (ANL/CNSV-TM—171) Study to develop a predicative technique for the estimation of collectible solid waste in the United States. (Franklin Associates Ltd., Prairie Village, KS (USA)). Jan 1985. Contract W-31-109-ENG-38. 138p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86012218.

This study gathers wastes generation rate data from several cities throughout the United States to test the reliability of the estimating equations developed in the 1979 study. Other parameters specifically seasonality, temperature, and precipitation, are examined to determine if they have a predictable effect on waste generation rate. Only municipal solid waste generation rates are examined in this study. Municipal waste includes all residential and commercial solid waste, but excludes industrial waste.

38885 (PB—86-190030/XAB) Surface-mine reclamation at the Elkins Mine Drainage Demonstration Project after 17 years. Hill, R.D.; Grube, W.E. (Environmental Protection Agency, Cincinnati, OH (USA). Hazardous Waste Engineering Research Lab.). Apr 1986. 9p. (EPA/600/D—86/081). NTIS, PC A02/MF A01.

In 1968 approximately 640 acres of land disturbed by coal mining were reclaimed and revegetated. The revegetation approach included the use of lime and fertilizer followed by seeding with a grass/legume mixture. In the steeper areas, pine trees were also planted. In areas designated for forest planting, a mixture of pines and deciduous trees was utilized. The revegetated areas were evaluated in 1971, 1973, 1976, 1984, and 1985. This paper discusses the results of the latter two evaluations.

38886 (PNL—5817) Environmental monitoring at Hanford for 1985. Price, K.R. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 216p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE86012295.

Environmental monitoring activities performed by the Pacific Northwest Laboratory for the Department of Energy on the Hanford Site for 1985 are discussed in this report. Samples of environmental media were collected to estimate radionuclide and chemical concentrations in the Hanford environment. Radiological impacts during 1985 in terms of radiation dose equivalents as a result of Hanford operations are also discussed. Applicable standards and concentration guides are given in Appendix C. As an aid to the reader, a glossary and conversion tables are given in Appendix B. The results provided in this report are summarized.

5106 Regulations

REFER ALSO TO CITATION(S) 38076, 38107, 38920

52 ENVIRONMENTAL SCIENCES, AQUATIC

5201 Basic Studies

REFER ALSO TO CITATION(S) 37322, 37327, 37644, 38881, 39016

38887 (DOE/BPA—22209-2) White sturgeon bibliography. Final report, 1985. Fickeisen, D.H. (USDOE Bonneville Power Administration, Portland, OR. Div. of Fish and Wildlife). Mar 1986. Contract AI79-84BP22209. 48p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86011675.

This bibliography presents citations to the majority of published materials on white sturgeon (Acipenser transmontanus). The purpose was to assist in planning and implementing research on white sturgeon in the Columbia River system. (ACR)

38888 (PNL-SA—13861) Generalization of one-dimensional solute transport. A stochastic-convective flow conceptualization. Simmons, C.S. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 14p. (CONF-8604214—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011117.

From 6. annual AGU front range branch hydrology days; Fort Collins, CO, USA (16 Apr 1986).

A stochastic-convective representation of one-dimensional solute transport is derived. It is shown to conceptually encompass solutions of the conventional convection-dispersion equation. This stochastic approach, however, does not rely on the assumption that dispersive flux satisfies Fick's diffusion law. Observable values of solute concentration and flux, which together satisfy a conservation

equation, are expressed as expectations over a flow velocity ensemble, representing the inherent random processess that govern dispersion. Solute concentration is determined by a Lagrangian pdf for random spatial displacements, while flux is determined by an equivalent Eulerian pdf for random travel times. A condition for such equivalence is derived for steady nonuniform flow, and it is proven that both Lagrangian and Eulerian pdfs are required to account for specified initial and boundary conditions on a global scale. Furthermore, simplified modeling of transport is justified by proving that an ensemble of effectively constant velocities always exists that constitutes an equivalent representation. An example of how a two-dimensional transport problems can be reduced to a single-dimensional stochastic viewpoint is also presented to further clarify concepts.

38889 **Biomass of freshwater turtles: a geographic comparison.** Congdon, J.D.; Greene, J.L.; Gibbons, J.W. (Savannah River Ecology Lab., Aiken, SC). *American Midland Naturalist;* **115**: No. 1, 165-173(Jan 1986).

From American industrial hygiene conference; Dallas, TX, USA (18-23 May 1986).

Standing crop biomass of freshwater turtles and minimum annual biomass of egg production were calculated for marsh and farm pond habitats in South Caroling and in Michigan. The species in South Carolina included Chelydra serpentina, Deirochelys reticularia, Kinosternon subrubrum, Pseudemys floridana, P. scripta and Sternotherus odoratus. The species in Michigan were Chelydra serpentina, Chrysemys picta and Emydoidea blandingi. Biomass was also determined for a single species population of P. scripta on a barrier island near Charleston, South Carolina. Population density and biomass of Pseudemys scripta in Green Pond on Capers Island were higher than densities and biomass of the entire six-species community studied on the mainland. In both the farm pond and marsh habitat in South Carolina P. scripta was the numerically dominant species and had the highest biomass. In Michigan, Chrysemys picta was the numerically dominant species; however, the biomass of Chelydra serpentina was higher. The three-species community in Michigan in two marshes (58 kg ha^{-1} and 46 kg ha^{-1}) and farm ponds (23 kg ha^{-1}) had lower biomasses than did the six-species community in a South Carolina marsh (73 kg^{-1}). Minimum annual egg production by all species in South Carolina averaged 1.93 kg ha^{-1} and in Michigan averaged 2.89 kg ha^{-1} of marsh.

5202 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 37306, 37462, 37474, 37475, 37476, 37850, 38798, 38865, 38871, 38878, 38908

38890 **(AD-A—165685/9/XAB) Bioaccumulation of toxins from dredged materials from the port of Hampton Roads, Virginia. Final report for period ending November 1984.** Alden, R.W.; Hall, G.J.; Jackman, S.S. (Old Dominion Univ., Norfolk, VA (USA). Applied Marine Research Lab.). Jan 1985. 78p. NTIS, PC A05/MF A01.

Exposure of test organisms to sediments taken from the highly industrialized portion of the Southern Branch produced statistically significant accumulation of chlorinated hydrocarbons, polynuclear aromatic hydrocarbons, and heavy metals. No PCBs were detected in the test organisms. Conclusion: Lower Southern Branch sediments are not acceptable for ocean disposal.

38891 **(AD-A—165870/7/XAB) Installation Restoration Program, Phase 2 - Confirmation/Quantification Stage i, Moody Air Force Base, Georgia. Final technical report, January 1984-December 1985.** Steinberg, J.A.; Thiess, W.G. (Water and Air Research, Inc., Gainesville, FL (USA)). Dec 1985. 252p. NTIS, PC A12/MF A01.

The Phase II Stage 1 Installation Restoration Program Confirmation/Quantification Survey for Moody Air Force Base investigated three suspected hazardous waste disposal sites. These included a former landfill site; a construction rubble fill site; and a petroleum, oil, and lubricants (POL) storage area. In addition, testing of all existing water supply (potable and industrial) wells was conducted. Shallow groundwater monitoring wells were installed at two of the sites. Shallow pits were excavated at the POL site. Shallow groundwater from monitor wells and pits, deeper groundwater from existing wells, and surface water were sampled. Most of these analyses were screening tests (pH, specific conductance, dissolved organic carbon (DOC), total organic halogens (TOX), total phenolics, and oil and grease), which are nonspecific indicators of contamination. Samples near waste sites were analyzed for specific constituents (cadmium chromium, iron, nickel, lead, zinc, dichlorodiphenyltrichloroethane (DDT), and purgeable organics) where prior information indicated they may be present. Samples from base supply wells were tested for selected nonspecific and specific constituents.

38892 **(CONF-860426—3) Some new cost-effective approaches for measuring organics associated with hazardous wastes.** Gammage, R.B.; Matthews, T.G.; Vo-Dinh, T. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011499.

From Symposium on measurement of toxic air pollutants; Raleigh, NC, USA (27 Apr 1986).

A number of newer and often highly sensitive analytical techniques and field monitoring devices are described that have potential suitability for monitoring organic hazardous wastes. The focus is on devices and methods that are cost-effective and permit either direct measurements in the field or screening-type measurements on samples returned to the laboratory for analysis. Most of these methods are directed at categories of less volatile organic compounds. The results of some very preliminary field tests are given. Most promising were the results obtained for a wide variety of ground and surface waters screened spectroscopically using synchronous fluorescence.

38893 **(CONF-8605137—1) Integrated fates and effects model for estimation of risk in aquatic systems.** Bartell, S.M. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011493.

From 10. symposium on aquatic toxicology and hazard assessment; New Orleans, LA, USA (4 May 1986).

An integrated fates and effects model was derived to simulate the toxic effects of naphthalene exposure on the growth of auatic populations. Effects on production were calculated on the basis of dose-response functions specific to each population in relation to changing concentrations of accumulated naphthalene. Separate simulations using constant environmental loading rates of 0.0001, 0.001, 0.01, and 0.10 g m^{-2} d^{-1} revealed changes in production that could not be extrapolated directly from acute toxicity bioassays. Estimted risks of 50% reduction in fish production ranged from 0.08 to 0.65 for loading rates of 0.000025 to 0.10 g m^{-2} d^{-1}. Examination of naphthalene flux through the model system indicated that the combined effects of photolysis and volatilization were more important than biological processes in determining the fate of naphthalene for the 0.10 loading rate. The relative importance of physicochemical versus biological processes reversed for the 0.0001 loading rate. At intermediate loading rates, the relative importance of these processes varied seasonally.

38894 **(CONF-8605137—2) Effect of dissolved organic macromolecules on exposure of aquatic organisms to organic contaminants.** McCarthy, J.F.; Black, M.C. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 33p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86011765.

From 10. symposium on aquatic toxicology and hazard assessment; New Orleans, LA, USA (4 May 1986).

Hydrophobic organic contaminants in aquatic systems bind to sediments or to suspended particles, and these associations affect the transport and bioavailability of contaminants and thus alter the exposure received by biota. We present evidence demonstrating the importance of another less obvious natural sorbent - dissolved organic macromolecules (DOM), such as dissolved humic materials - in altering the environmental fate of contaminants. Binding of a polyaromatic hydrocarbon, benzo[a]pyrene, to DOM and to particles was measured for each sorbent and in a mixed system containing both sorbents. DOM competed with particles for binding of the dissolved contaminant and reduced the amount bound to particles. Binding to each sorbent was independent and noninteractive. Based

on these results, equations were developed to indicate those environments and ecosystems for which failure to account for the role of DOM as a sorbent would result in 50 or 90% errors in steady state predictions about the exposure of aquatic organisms to contaminants.

38895 **(DPST—84-791) Pilot-scale reverse osmosis testing for the F and H Area Effluent Treatment Facility.** Kessler, J.L. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 27 Sep 1984. Contract AC09-76SR00001. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011836.

Pilot-scale reverse osmosis (RO) tests were completed with a 10 gpm unit to demonstrate the performance of RO in the F and H Area Effluent Treatment Facility (F/H ETF). RO will be used in the WMETF to remove soluble salts and soluble radioactivity. The advantage of using RO (over ion exchange) is that it is nondescriminanting and removes virtually all dissolved solids species, regardless of ionic charge. RO also generates less than half the waste volume produced by ion exchange. Test results using a 200-Area nonradioactive effluent simulant demonstrated salt rejections of 98% and water recoveries of 94% by using recycle on a single stage pilot unit. For a full-scale, multi-staged unit overall salt rejections will be 95% (DF = 20) while obtaining a 94% water recovery (94% discharge, 6% concentrated waste stream). Identical performance is expected on actual radioactive streams, based on shielded cells testing performed by Motyka and Stimson. Similarly, if the WMETF RO system is configured in the same manner as the SRL ECWPF, a DF of 20 and a water recvery of 94% should be obtained.

38896 **(GKSS—86/E/2) Formation of particulate suspended matter and its influence on bounding and distribution of ecotoxic heavy metals in the tidal influenced Elbe river.** Irmer, U.; Knauth, H.D.; Weiler, K. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). 1985. 26p. (In German). NTIS, PC E02; Available from NTIS as TIB/B86-06434.

The chlorophyll a content of water samples correlated well with the contents of SPM, organic substance. These strong correlations suggested a significantly influenced SPM formation by growth of algae. Negative correlations between phytoplankton dynamic and Hg-, Pb- and Cd-content of SPM showed corresponding minima of metals at time of maximal algal bloom. The results suggest that in summer time a considerable 'dilution' of highly polluted SPM transported by the upper water occurred, caused by the observed mass-enrichment of phytoplankton found in shallow water regions of the tidal influenced Elbe river. Such induced decrease of Hg-, Pb- and Cd-content of seston was additionally intensified by an increased sedimentation of autochthonous SPM in still water areas of the widely branched Port of Hamburg. Comparing the annual distribution average of metals between solution and particulates lead proved to be the most sestonbound metal (89%), in sequence followed by iron (85%), cadmium (79%), copper (74%), mercury (68%) and in distinct distance manganese (16%). (orig./PW).

38897 **(INIS-mf—9881) Trace element analysis of the heavy metals lead, cadmium and thallium in water and samples of organic matter using mass spectroscopy and isotope dilution analysis.** Trettenbach, J. (Regensburg Univ. (Germany, F.R.). Naturwissenschaftliche Fakultaet 4 - Chemie und Pharmazie). 26 Nov 1984. 185p. (In German). NTIS (US Sales Only), PC A09/MF A01. File Number DE86752087.

A multielement analysis technique was on the basis of accurate isotope measurements. The accuracy of the measurements was tested using an isotope standard. Water, plants, foodstuffs, and blood were analyzed. The organic samples were decomposed using nitric acid and hydrogen peroxide, and the metals were deposited by electrolysis on a platinum electrode and extracted. The detection limit of the technique was in the pg range. (PW).

38898 **(ORNL—6179) Water quality criteria for nitrocellulose. Final report.** Ryon, M.G. (Oak Ridge National Lab., TN (USA)). Jun 1986. Contract AC05-84OR21400. 82p. NTIS, PC A05/MF A01; GPO Dep. File Number DE86012039.

Based on available data for four species of mcroinvertebrates, four species of fish, and three species of algae, nitrocellulose does not appear to be very toxic for most aquatic species. In the majority of evaluations the EC_{50} and LC_{50} values were >1000 mg/L. Only for the effect on the chlorophyll a content of Selenastrum caprecornutum was a lower value estimated, an EC_{50} of 579 mg/L (Bentley et al. 1977). The available data on the human health effects and mammalian toxicity of nitrocellulose generally suggest that it is virtually nontoxic. The acute toxicity data indicated LD_{50} values in excess of 5000 mg/kg. However, nitrocellulose does appear to produce significant abiotic environmental effects when released from Army Ammunition Plants. Because of its fibrous nature, nitrocellulose would tend to blanket benthic habitats (perhaps depriving organisms of oxygen) and fill in interstitial spaces used as cover for benthic invertebrates and substrates for periphyton. This potential for habitat alteraction is further compounded by the apparent resistance of released nitrocellulose to environmental degradation. When contrasted to the low toxicity of the compound, this habitat alteration becomes a significant aspect of regulatory control.

38899 **(PB—86-184421/XAB) Validity of effluent and ambient toxicity tests for predicting biological impact, Skeleton Creek, Enid, Oklahoma.** Norberg-King, T.J.; Mount, D.I. (Environmental Protection Agency, Duluth, MN (USA). Environmental Research Lab.). Mar 1986. 35p. NTIS, PC A03/MF A01.

Skeleton Creek was studied in August, 1983 and was the fourth site study. A small creek, Boggy Creek receives discharges from both an oil refinery and a publicly owned treatment works (POTW) prior to its confluence with Skeleton Creek. A fertilizer-processing-plant discharge is located on Skeleton Creek just downstream of the confluence of the two streams. The toxicity of two effluents and ambient stream stations was evaluated. Hydrological and ecological field surveys were also done. A comparison of the relationship between the measured toxicity of the water samples collected from the streams and the health of the aquatic community at the same stream stations is made.

38900 **(PB—86-184744/XAB) Control of organic substances in water and waste water.** Berger, B.B. (Massachusetts Univ., Amherst (USA). Dept. of Civil Engineering). Apr 1983. 482p. NTIS, PC A21/MF A01.

The presence of organic substances of industrial origin in waste waters, storm runoff, and in surface and groundwaters may not always be an unmitigated evil--but, it is safe to say, it never is good. In 1976, EPA was required to give special emphasis to 129 priority pollutants that present probable hazard in the water resource. Of these 129 priority pollutants, 114 are organic. This document is comprised of 14 chapters, each prepared by a specialist. Chapter 1, Fundamental Considerations in the Removal of Organic Substances in Water is, in esence, an examination of a wide spectrum of physical-chemical principles that are being used, are under study, or may in the future be adapted for use in the separation of organic pollutants in waters.

38901 **(PB—86-191046/XAB) Study of biological processes on the US Mid-Atlantic slope and rise. Second interim report. Report for May 1984-September 1985.** Maciolek, N.; Grassle, J.F.; Boehm, P.D.; Dade, B.; Brown, B. (Battelle New England Marine Research Lab., Duxbury, MA (USA)). 24 Feb 1986. 187p. NTIS, PC A09/MF A01.

Samples collected on the first four of six cruises to the U.S. Mid-Atlantic as part of a study to evaluate potential effects of drilling have been analyzed for benthic infauna, hydrocarbons, sediment grain size, and total organic carbon, hydrogen, and nitrogen. There is no evidence that the hydrocarbons in the sediments originate from sources associated with drilling activities. A very subtle change in the fauna at the drill site station in Block 372 was detected. Species diversity declined at Station 1 over time, but this trend is not statistically significant. The density of at least one dominant species was significantly lower in post-drilling samples compared to pre-drilling samples, but the density of the species was not significantly different at Station 1 compared to the majority of 2100 m stations for any sampling period.

38902 **(PNL-SA—12297) Temporal trends of contamination of Puget Sound.** Crecelius, E.A.; Bloom, N. (Pacific Northwest Labs., Richland, WA (USA)). Oct 1984. Contract AC06-76RL01830. 27p. (CONF-8409222—2). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011608.

From 5. international ocean disposal symposium; Corvallis, OR, USA (10 Sep 1984).

Trends in contaminant loading to the central basin of Puget Sound have been inferred from the chemical composition of age-dated sediment cores. During the last hundred years there have been dramatic changes in the quantity of specific heavy metals and organic compounds entering Puget Sound. The sedimentary history of several chemicals, including Pb, Hg, Ag, Cu, As and hydrocarbons, shows increased concentrations paralleling the urbanization of the Seattle-Tacoma area. Contaminant concentrations began to increase above background in the late 1800s and reached maximum concentrations usually in sediments deposited in 1945 to 1965. Synthetic organics such as PCB, DDT and CBD first appear in sediments deposited in the 1930s or later and reached a maximum in the 1960s. The presence of the subsurface maximum concentrations in the fine-grain deepwater sediments indicates the pollution control strategies have significantly improved the sediment quality of central Puget Sound.

38903 **(SNV—3042) Mercury. Occurrence and turnover of mercury in the environment. Status report October 1985.** Lindqvist, O.; Johansson, K.; Timm, B.; Levander, T.; Hovsenius, G. (National Swedish Environmental Protection Board, Solna). Oct 1985. 34p. (In Swedish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752156.

The National Swedish Environmental Protection Board and some industry branches have started up research work concerning mercury in the environment. During the period 1984/1985-1988/1989 the following fields will be studied: 1 Swedish emissions of mercury into the atmosphere. 2. Mercury in the air. Sources, transport and deposition. 3. Occurrence and turnover of mercury in terrestrial ecosystems. 4. Occurrence and turnover of mercury in aquatic ecosystems. The first year has mainly been used for planning and initiation of work. Research work concerning development of analysis and sampling methods. Already ongoing investigations concerning mercury in air and precipitation is continuing. Mapping of mercury in soil and water has been started. This report summarizes current research and results.

38904 **(SVF—195) Operation experiences with polyamine dosing to condition feed water, boiler water and condensate.** Persson, F. (Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden)). Jan 1985. 149p. (In Swedish). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752148.

Experiences from 25 plants has been collected with the following results. 1. The content of iron in condensate and feed water has decreased in most plants after start of polyamine dosing, which proves that the general corrosion in boilers and pipelines has decreased. 2. In one plant there is no deaeration of the feed water. The content of iron has in this plant been higher when dosing of polyamine than with earlier dosing of tannin products. 3. Corrosion has occurred in the feed water tank in a plant. The operation in this plant is intermittent. The dosing of polyamine was started 1982. The feed water tank was so corroded 1983 that it had to be replaced. The new tank was inspected after 6 months operation. Pittings were discovered at the water level. 4. Greasy deposits have been formed in many plants in condensate and feed water systems with operation disturbances in strainers, steam traps and condensate filters. 5. To avoid greasy deposits, recommended dosing quantities has been decreased to such low levels that in many cases no content of amine has been measured in condensate and feed water. 6. The surface of the waterside in the boilers has in many cases been red or has a red tone. The red colour is caused by hematite formation. 7. In four plants leakage has occurred in boilers which has been operated for several years with conventional chemicals. Leakages have occurred in welds and at rolled in tubes within a year after start of polyamine dosing. 8. The cost for dosing with polyamine is in general higher than for dosing with conventional chemicals as phosphate, hydrazine and amine for alkalization of condensate. The results from test runs with polyamine products in two district heating plants are included in the report. The content of carbon dioxide in the steam is high and heat exchangers for steam were badly corroded. Polyamine dosing could not decrease the corrosion.

38905 **Detecting chloroorganics in groundwater.** Milanovich, F.P. (Lawrence Livermore National Lab., CA). *Environmental Science and Technology;* **20**: No. 5, 441-442(May 1986).

Optical fibers, chemistry, lasers, and fluorescence spectroscopy have been combined to form remote fiber fluorimetry (RFF). The key to RFF is the use of fiber-optic chemical sensors (FOCSs). The RFF system has been used to measure volatile chloroorganics in groundwater and the vadose zone. This new technology provides an analytical capability where traditional systems have not been practical or feasible. FOCSs were tested in Henderson, Nevada, in wells that were known to contain chloroform. Backup analysis provided an independent reference for the in-situ measurements. 2 references, 3 figures.

38906 **Supercritical fluid processing.** Eckert, C.A.; Van Alsten, J.G.; Stoicos, T. (Univ. of Illinois, Urbana). *Environmental Science and Technology;* **20**: No. 4, 319-325(Apr 1986). Contract FG22-84PC70801.

Separation and detoxification reactions often can be run advantageously using supercritical fluids (SCFs) as processing media. The use of a supercritical solvent frequently permits extraction of very dilute toxic species, either directly or in a two-step process. SCF solvents not only increase reactivity but offer the potential for simultaneous separation and detoxification. SCF technology is a powerful tool that has a bright future in environmental engineering applications.

38907 **Interactions between polycyclic aromatic hydrocarbons and dissolved humic material: binding and dissociation.** McCarthy, J.F.; Jimenez, B.D. (Oak Ridge National Lab., TN). *Environmental Science and Technology;* **19**: No. 1, 1072-1076(Nov 1985).

Binding of polycyclic aromatic hydrocarbons (PAH's) to dissolved humic material (DHM) was examined by using equilibrium dialysis and fluorescence techniques. There was a direct relationship between the hydrophobicity of the PAH and the affinity for binding to DHM. The binding affinity P/sub a/ for benzo[a]pyrene (BaP), benzanthracene, and anthracene decreased slightly as the concentration of DHM increased. The binding of BaP to DHM was completely reversible and the extent of reversibility was unrelated to the sorption time. The rate of binding of BaP to DHM, measured by the quenching to BaP fluorescence, was very rapid and was completed within 5-10 min. The results suggest that the presence of DHM, or other sorptive components of the dissolved organic pool, may affect binding to sediment or suspended particles and thus alter the fate and transport of organic contaminants in aquatic systems.

5203 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 37537, 37538, 37539, 37549, 37556, 37558, 37560, 37590, 37591, 37594, 37632, 37633, 37634, 37639, 37642, 37645, 37659, 37660, 38855, 38882

38908 **(PNL-SA—13539) Sediment and contaminant transport in a marine environment.** Onishi, Y.; Thompson, F.L. (Pacific Northwest Labs., Richland, WA (USA)). Jan 1986. Contract AC06-76RL01830. 10p. (CONF-8603129—1). NTIS, PC A02/MF A01 - GPO. File Number TI86011135.

From 3. international symposium on river sedimentation; Jackson, MS, USA (31 Mar 1986).

The finite-element model FETRA is an unsteady, verically averaged two-dimensional model to simulate the transport of sediment and contaminants (radionuclides, heavy metals, pesticides, etc.) in coastal and estuarine water. The model, together with the hydrodynamic model CAFE-I, was applied to the Irish Sea to predict the migration and accumulation of sediment (both cohesive and noncohesive) and of a radionuclide (dissolved and sediment-sorbed) in a tide- and wind-driven system. The study demonstrated that

FETRA is a useful tool for assessing sediment and toxic contaminant transport in a marine environment.

38909 **(UCID—20367) Environmental radiological studies downstream from Rancho Seco Nuclear Power Generating Station.** Noshkin, V.E.; Wong, K.M.; Eagle, R.J.; Dawson, J.W.; Brunk, J.L.; Jokela, T.A. (Lawrence Livermore National Lab., CA (USA)). 22 Mar 1985. Contract W-7405-ENG-48. 63p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86011019.

This report summarizes the information compiled in 1984 while assessing the environmental impact of radionuclides in aquatic releases from the Rancho Seco Nuclear Power Generating Station. Gamma-emitting radionuclides discharged since 1981 are found in many of the dietary components derived from the creeks receiving the effluent wastewater. Some soils and crops are found to contain radionuclides that originate from the contaminated water that was transferred to land during the irrigation season. ^{134}Cs and ^{137}Cs are the primary gamma-emitting radionuclides detected in the edible flesh of fish from the creeks. Concentrations in the flesh of fish decreased exponentially with distance from the plant. No significant differences in the ^{137}Cs activity were found between male and female fish of equal size, but concentrations may vary in fish of different size, with the season and diet. 21% of the total ^{137}Cs and ^{134}Cs discharged between 1981 and 1984 is associated with the creek sediments to a distance of 27 km from the plant. Fractions of the missing inventory have been transferred to land during the irrigation season or to downstream regions more distant than 27 km from the plant. The radiocesium content of the sediments in 1984 decreased significantly in a downstream direction, much in the same manner as concentrations decreased in fish. Radioactivity originating from the plant was not above detection limits in any terrestrial food item sampled beyond 6.5 km from the plant. Based on the usage factors provided by individuals interviewed in a 1984 survey, the fish and aquatic-organism ingestion pathway contributed the largest radiological dose to humans utilizing products contaminated with the radionuclides in the liquid wastes discharged from the Rancho Seco Nuclear Power Generating Station in 1984.

38910 **(UCID—20641-Pt.1) Environmental radiological studies downstream from the Rancho Seco Nuclear Power Generating Station, 1985.** Noshkin, V.E.; Wong, K.M.; Eagle, R.J.; Brunk, J.L.; Jokela, T.A. (Lawrence Livermore National Lab., CA (USA)). 6 Feb 1986. Contract W-7405-ENG-48. 43p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011014.

Information compiled in 1985 while assessing the environmental impact of radionuclides previously discharged with aqueous releases from the Rancho Seco Nuclear Power Generating Plant is presented. In October 1984, the quantities of gamma-emitting radionuclides in water discharged to Clay Creek from the plant were reduced below operationally defined detection limits for liquid effluents. However, radionuclides previously discharged persist in the downstream environment and are found in many aquatic dietary components. ^{134}Cs and ^{137}Cs are the primary gamma-emitting radionuclides detected in the edible flesh of different fish, crayfish, and frogs. Coefficients for exponential equations are generated, from a least square analysis, that relate the change in concentration of ^{137}Cs in fish to distance downstream and time between March and October 1985. Concentrations of ^{137}Cs in surface creek sediments also decreased in the downstream direction much in the same manner as concentrations decreased in fish. However, there was no significant difference in the radiocesium concentrations in surface sediements collected from comparable locations during both 1984 and 1985.

38911 **(UCID—20641-Pt.2) Environmental radiological studies downstream from the Rancho Seco Nuclear Power Generating Station - 1985. Appendices. Part II.** Noshkin, V.E.; Wong, K.M.; Eagle, R.J.; Brunk, J.L.; Jokela, T.A. (Lawrence Livermore National Lab., CA (USA)). 23 Jan 1986. Contract W-7405-ENG-48. 91p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012604.

Eight appendices address the following concentrations of radionuclides: in fish; in frog legs; in crayfish; in sediments; in soil samples; in surface and ground water samples; in water hyacinths; and in beef samples.

38912 **Pu(V) as the stable form of oxidized plutonium in natural waters.** Orlandini, K.A.; Penrose, W.R.; Nelson, D.M. (Argonne National Lab., IL, USA). *Marine Chemistry (Amsterdam);* **18**: No. 1, 49-57(Feb 1986).

This work presents analytical evidence supporting the proposition that Pu(V) is the sole or predominant form of oxidized plutonium in natural waters. Two independent methods, the selective adsorption of Pu(VI) by silica gel, and the somewhat less selective coprecipitation of Pu(V) with calcium carbonate, were developed to separate Pu(V) from Pu(VI). Measurements of ambient plutonium in several natural waters by these methods found only Pu(V). In laboratory tracer studies, Pu(VI) was shown to be highly unstable in dilute bicarbonate solution and in Lake Michigan water, reducing in first-order fashion to Pu(V). 11 refs.; 2 figs.; 2 tabs.

38913 **Uranium isotope distribution in ground water at the Shiprock Mill site.** Price, J.B.; Rice, G. (Sergent, Hauskins, and Beckwith, Albuquerque, NM). pp 189-198 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

Uranium is the most mobile of the radioactive elements which are found in ground water at the Uranium Mill Tailings Remedial Action (UMTRA) Project former milling sites. In most natural ground waters there is an approximately equal distribution between the radioactivity of the ^{234}U and ^{238}U isotopes of uranium. The milling process and the decay chain of uranium can increase or decrease the ratio of $^{234}U/^{238}U$ in ground water near milling sites. The areal distribution of $^{234}/^{238}U$ in aqueous form is examined for the Shiprock, New Mexico tailings as a possible tool for characterizing ground water.

38914 **Evaluating geomorphic hazards from river behavior -- Durango, Riverton, and Gunnison UMTRA Project sites.** Gillam, M.L.; Weeks, R.E. (Sergent, Hauskins and Beckwith Engineers). pp 143-152 of Management of uranium mill tailings, low-level waste, and hazardous waste. Fort Collins, CO; Colorado State University (1985). (CONF-850242—). Contract AC04-82AL14086.

From 7. symposium on management of uranium mill tailings, low-level waste and hazardous waste; Ft. Collins, CO, USA (6 Feb 1985).

The geomorphic settings of three UMTRA Project sites and methods used to evaluate associated fluvial hazards are reviewed. The results of these studies, and a comparison with separate analyses of the probable maximum flood (PMF) at each site, yield the following conclusions: 1) a reconnaissance is the preferred method for defining the needed scope and emphasis of geomorphic hazard evaluations; 2) the reliability of an evaluation is grossly affected by the geologic recored preserved in each study area; 3) in many cases, the probability of a hazard from slow erosional processes may be higher than the probability of catastrophic flooding; and 4) the Holocene geologic record may not contain evidence of floods similar to the calculated PMF.

5205 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 37727, 38944

38915 **(DPST—84-252) Savannah River Aquatic Ecology Program. Volume I. Annual report, September 1982-August 1983.** Paller, M.; O'Hara, J.; Osteen, V.; Specht, W.; Kania, H. (Environmental and Chemical Sciences, Inc., Aiken, SC (USA)). Jan 1984. Contract AC09-76SR00001. 275p. (ECS-SR—8). NTIS, PC A12/MF A01; 1; GPO Dep. File Number DE86010325.

This document reports on the Savannah River Aquatic Ecology Program for the period September 1982 through August 1983. Volume I covers fisheries studies including ichthyoplankton, entrainment, impingement, diurnal studies, adult fish studies and special quality assurance tests and quality assurance programs.

38916 (NHL—284052) Environmental data collection north of 62 degrees N-Tromsoeflaket. Progress report No. 15. Jacobson, P. (Norsk Hydroteknisk Lab., Trondheim). 1984. 135p. (STF—60A84052). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752132.

This progress report contains current and wave data from position 71 degrees 31'N, 19 degrees 00'E at Tromsoeflaket off the coast of northern Norway. This report is No. 15 in a series that since the beginning of 1980 and up to report No. 12 was published as international reports. 61 tables, 172 drawings.

38917 (NHL—284142) Environmental data collection north of 62 degrees N-Tromsoeflaket Progress report No. 16. Hansen, S. (Norsk Hydroteknisk Lab., Trondheim). 1984. 145p. (STF—60A4142). NTIS (US Sales Only), PC A07. File Number DE86752133.

This progress report contains current and wave data from position 71 degrees 31'N, 19 degrees 00'E at Tromsoeflaket off the coast of northern Norway. This report is No. 16 in a series that since the beginning of 1980 and up to report No. 12 was published as internaional reports. 90 tables, 212 drawings.

38918 (NHL—284143) Enviromental data collection north of 62 degrees N-Tromsoeflaket. Progress report No. 17. Hansen, S. (Norsk Hydroteknisk Lab., Trondheim). 1984. 205p. (STF—60A84143). NTIS (US Sales Only), PC A10. File Number DE86752134.

This progress report contains current and wave data form position 71 degrees 31'N, 19 degrees 00'E at Tromsoeflaket off the coast of northern Norway. This report is No. 17 in a series that since the beginning of 1980 and up to report No. 12 was published as international reports. 131 tables, 329 drawings.

38919 (NHL—284144) Environmental data collection north of 62 degrees N-Tromsoeflaket. Progress report No. 18. Hansen, S. (Norsk Hydroteknisk Lab., Trondheim). 1984. 223p. (STF—60A84144). NTIS (US Sales Only), PC A10. File Number DE86752135.

This progress report contains current and wave data from position 71 degrees 31'N, 19 degrees 00'E at Tromsoeflaket off the coast of northern Norway. This report is No. 18 in a series that since the beginning of 1980 and up to report No. 12 was published as international reports. 121 tables, 414 drawings.

5206 Regulations

REFER ALSO TO CITATION(S) 37634

38920 (GAO/RCED—86-7) Acid rain. Federal research into effects on waters and forests. (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). Dec 1985. 54p. U.S. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877. File Number TI86901428.

Report to the Chairman, Sub Committee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives.

Research directed at identifying the adverse effects of acid deposition on lakes and streams included 81 projects as of the end of fiscal year 1985. Initial task force analyses of research results indicate that certain lakes in the eastern states are acidic. Under the task force's present research schedule, it will be a year or more before research determines the condition of other lakes and streams identifies which lakes have a high potential of becoming acidic in the future, and addresses questions about the extent of damage done to fish and other aquatic life. Research directed at identifying the adverse effects of acid deposition on forests included 17 projects as of the end of fiscal year 1985. Forests did not emerge as a major research issue until 1983, and research funding for forest effects in fiscal year 1985 tripled the total funding for the three previous fiscal years. The task force estimates that it will be 5 or more years before research defines the extent of forest decline and acid deposition's role in forest change. Acid deposition research funding increased from $29 million in fiscal year 1984 to $65 million in fiscal year 1985. The fiscal year 1986 proposed budget calls for $85.4 million; about 51% of this funding is slated for work on water and forest research. No recommendations are given.

53 ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

5301 Social And Economic Studies

38921 Challenges to socio-economic impact modeling: lessons from the Alaska OCS Program. Leistritz, F.L.; Chase, R.A.; Ekstrom, B.L.; Knapp, G.; Huskey, L.; Murdock, S.H.; Scott, M.J. (North Dakota State Univ., Fargo). *Journal of Environmental Management;* 21: No. 4, 301-319(Dec 1985).

Accurately assessing the socio-economic impacts of large-scale resource developments is a complex undertaking which must take account of the conditions under which development is occurring, including the local environmental, economic, social, and cultural conditions. Such impact assessments and modeling efforts are also affected by the policy context of model development. Thus, such factors as the characteristics of the project, the diversity of potential information demands, population and settlement densities, the local economic structure, and the demographic and socio-cultural uniqueness of the affected area all influence the accuracy and usefulness of assessments. This paper examines the context that has surrounded the development and use of models for assessing the socio-economic impacts of outer continental shelf (OCS) petroleum development on rural villages in Alaska - a setting which posed major challenges for impact modelling because of its unique characteristics. It thus provides both a description of the pragmatic steps and an example of the general principles necessary to design and use such models effectively.

5302 Assessment Of Energy Technologies

REFER ALSO TO CITATION(S) 37638

5303 Environmental Impact Statements

38922 (DOE/EIS—0123F) Direct service industry options. Final enrivonmental impact statement. (Bonneville Power Administration, Portland, OR (USA)). Apr 1986. 318p. NTIS, PC A14/MF A01; 1; GPO Dep. File Number DE86011907.

BPA propoes to implement one or more options to reduce load fluctuations and revenue uncertainty resulting from its electrical service to 10 aluminum smelters and its other direct service industrial customers. BPA believes these options will give BPA greater ability to plan for power needs and help to maintain its relatively strong financial position during the current period of power surplus. They also are expected to enhance BPA's ability to repay the US Treasury. In turn, BPA rates to other customers would stabilize. The final EIS evaluates the effects of four options and their alternatives: No Action; the Variable Rate; the aluminum smelter Conservation/Modernization program; and the IP-PF Rate Link. The EIS also evaluates the cumulative effect of implementing more than one option. The major effects examined include aluminum smelter options, resource operations and development, and socio-economic impacts. Potential envionmental impacts (generally benefits) and potentially major, localized adverse socioeconomic impacts are likely under the no action alternative, a result of closures of or reduced operations at certain Northwest aluminum smelters. The options have a varying effect on the operation and continued viability of Northwest aluminum smelters with consequent environmental and socioeconomic impacts. No decision on any of the four options will be made until 18 days after the Environmental Protection Agency has published the Notice of filing of this final EIS in the Federal Register.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

REFER ALSO TO CITATION(S) 38945

5502 Biochemistry

REFER ALSO TO CITATION(S) 37719, 38939

38023 Distribution of protein and RNA in the 30S ribosomal subunit. Ramakrishnan, V. (Brookhaven National Lab., Upton, NY). *Science (Washington, D.C.);* No. 4745, 1562-1564(28 Mar 1986).

In Escherichia coli, the small ribosomal subunit has a sedimentation coefficient of 30S, and consists of a 16S RNA molecule of 1541 nucleotides complexed with 21 proteins. Over the last few years, a controversy has emerged regarding the spatial distribution of RNA and protein in the 30S subunit. Contrast variation with neutron scattering was used to suggest that the RNA was located in a central core of the subunit and the proteins mainly in the periphery, with virtually no separation between the centers of mass of protein and RNA. However, these findings are incompatible with the results of efforts to locate individual ribosomal proteins by immune electron microscopy and triangulation with interprotein distance measurements. The conflict between these two views is resolved in this report of small-angle neutron scattering measurements on 30S subunits with and without protein S1, and on subunits reconstituted from deuterated 16S RNA and unlabeled proteins. The results show that (i) the proteins and RNA are intermingled, with neither component dominating at the core or the periphery, and (ii) the spatial distribution of protein and RNA is asymmetrical, with a separation between their centers of mass of about 25 angstroms.

38024 Appearance and accumulation of C_4 carbon pathway enzymes in developing wheat leaves. Aoyagi, K.; Bassham, J.A. (Lawrence Berkeley Lab., CA). *Plant Physiology;* 80: No. 2, 334-340(Feb 1986). Contract AC03-76SF00098.

Soluble protein has been extracted from sections of wheat leaves, from base to tip, and the content of several key enzymes of photosynthetic carbon assimilation in each section has been determined by the protein blot method. In the first leaf, ribulose 1,5-bisphosphate carboxylase (RuBPC) (EC 4.1.1.39) in the basal 0 to 1 centimeter section is about 12% the level in the tip section, whereas phosphoenolpyruvate carboxylase (EC 4.1.1.31) is present in small amounts in the basal section and does not change much in the tip. Pyruvate orthophosphate dikinase (PPDK) (EC 2.7.9.1) first appears in the 4 to 6 centimeter section and increases gradually with development to 10-fold in the tip. Malic enzyme, NADP-dependent (EC 1.3.1.37) also appears in the 4 to 6 centimeter section but remains low to the tip. Fixation of $^{14}CO_2$ by wheat leaf base sections resulted in 42% of total incorporation into malate and aspartate, indicating β-carboxylation, whereas in the tip section these labeled compounds were only 8% of the total. Although the amount of PPDK in wheat leaves is only 1 to 3% of that in maize leaves, this C_3 PPDK may have a limited role in photosynthesis leading to formation of C_4 compounds. The possibility of a further role, similar to that in C_4 plants, but for intracellular carbon transport in wheat leaves is discussed. The presence of malic dehydrogenase, NADP-specific (EC 1.1.1.82) in wheat leaf chloroplasts was shown, a necessary though not sufficient condition for such a proposed role. Assuming each of the four enzymes associated with C_4 carbon transport were fully active in vivo during photosynthesis, PPDK would still be rate limiting, even in the leaf tip where its activity is maximal. Possible evolutionary and breeding implications are discussed.

38025 Host-pathogen interactions. XXIX. Oligogalacturonides released from sodium polypectate by endopolygalacturonic acid lyase are elicitors of phytoalexins in soybean. Davis, K.R.; Darvill, A.G.; Albersheim, P.; Dell, A. (Univ. of Colorado, Boulder). *Plant Physiology;* 80: No. 2, 568-577(Feb 1986). Contract AC02-76ER01426.

Recent studies have demonstrated that an apparently homogeneous preparation of an α-1,4-D-endopolygalacturonic acid lyase (EC 4.2.2.2) isolated from the phytopathogenic bacterium Erwinia carotovora induced phytoalexin accumulation in cotyledons of soybean (Glycine max [L.] Merr. cv Wayne) and that this pectin-degrading enzyme released heat-stable elicitors of phytoalexins from soybean cell walls, citrus pectin, and sodium polypectate. The present paper reports the purification, by anion-exchange chromatography on QAE-Sephadex columns followed by gel-permeation chromatography on a Bio-Gel P-6 column, of the two fractions with highest specific elicitor activity present in a crude elicitor-preparation obtained by lyase treatment of sodium polypectate. Structural analysis of the fraction with highest specific elicitor activity indicated that the major, if not only, component was a decasaccharide of α-1,4-D-galactosyluronic acid that contained the expected product of lyase cleavage, 4-deoxy-β-L-5-threo-hexopyranos-4-enyluronic acid (4,5-unsaturated galactosyluronic acid), at the nonreducing terminus. This modified decagalacturonide fraction exhibited half-maximum and maximum elicitor activity at 1 microgram/cotyledon (6 micromolar) and 5 micrograms/cotyledon (32 micromolar) galactosyluronic acid equivalents, respectively. Reducing 90 to 95% of the carboxyl groups of the galactosyluronic acid residues abolished the elicitor activity of the decagalacturonide fraction. The second most elicitor-active fraction contained mostly undeca-α-1,4-D-galactosyluronic acid that contained 4,5-unsaturated galactosyluronic acid at the nonreducing termini. This fraction exhibited half-maximum and maximum elicitor activity at approximately 3 micrograms/cotyledon (17 micromolar) and 6 micrograms/cotyledon (34 micromolar) galactosyluronic acid equivalents, respectively.

38026 Compartmentation and equilibration of abscisic acid in isolated Xanthium cells. Bray, E.A.; Zeevaart, J.A.D. (Michigan State Univ., East Lansing). *Plant Physiology;* 80: No. 1, 105-109(Jan 1986). Contract AC02-76ER01338.

The compartmentation of endogenous abscisic acid (ABA), applied (+/-)-[^{3}H]ABA, and (+/-)-trans-ABA was measured in isolated mesophyll cells of the Chicago strain of Xanthium strumarium L. The release of ABA to the medium in the presence or absence of DMSO was used to determine the equilibration of ABA in the cells. It was found that a greater percentage of the (+/-)-[^{3}H]ABA and the (+/-)-trans-ABA was released into the medium than of the endogenous ABA, indicating that applied ABA did not equilibrate with the endogenous material. Therefore, in further investigations only the compartmentation of endogenous ABA was studied. Endogenous ABA was released from Xanthium cells according to the pH gradients among the various cellular compartments. Thus, darkness, high external pH, KNO_3, and drought-stress all increased the efflux of ABA from the cells. Efflux of ABA from the cells in the presence of 0.6 M mannitol occurred within 30 seconds, but only 8% of the endogenous material was released during the 20 minute treatment.

38027 Formation of phospholipid-rich HDL: a model for square-packing lipoprotein particles found in interstitial fluid and in abetalipoproteinemic plasma. Forte, T.M.; Ren, C.L.; Nordhausen, R.W.; Nichols, A.V. (Lawrence Berkeley Lab., CA). *Biochimica et Biophysica Acta;* 834: 386-395(1985).

The major bovine HDL subfraction, fraction I-HDL, was incubated with increasing amounts of dimyristoylphosphatidylcholine (DMPC). HDL size, as determined by gradient gel electrophoresis and electron microscopy, increased with increasing HDL-phospholipid to DMPC mole ratios. Control fraction I-HDL were spherical, hexagonally-packing particles with a peak on gradient gel electrophoresis at 12.3 +/- 0.1 nm; at a ratio of 1:0.5, larger, mainly spherical particles with a peak at 12.9 +/- 0.08 nm were formed. At a ratio of 1:1, occasional square-shaped particles were seen by electron microscopy; by gradient gel analysis, the mean diameter of the HDL-product increased to 13.7 +/- 0.1 nm. At the 1:2 ratio, extensive domains of square-packing particles were noted; the major size peak of this product was 14.6 +/- 0.08 nm. In all incubations with DMPC, a small 9.4 +/- 0.08 nm product was formed; it was most pronounced at the 1:2 ratio. The large, less dense particles generated by incubation contained apolipoprotein A-I and small molecular weight proteins. The 9.4 nm product contained only apolipoprotein A-I. The less dense product formed during incubation at the 1:2 ratio had a decreased protein-to-lipid ratio relative to control HDL and a 2-fold increase in percent phospholipid. At a 1:2 ratio, incorporation of DMPC into fraction I-HDL results

in the loss of one molecule of apolipoprotein A-I; the resultant particle is a stable phospholipid-rich and protein-poor HDL which has a square-packing geometry. These phospholipid-laden HDL are morphologically similar to lipoproteins isolated from interstitial fluid or from plasma of abetalipoproteinemic patients. These data suggest that the unusual morphological properties of the latter biologically formed particles may be due to increases in the polar lipid contents, and concomitant decreases in surface protein. 27 references, 6 figures, 2 tables.

5505 Metabolism

REFER ALSO TO CITATION(S) 38970

38928 Distribution of label after intragastric administration of ^{7}Be-labeled carbon to weanling and aged mice. LeFevre, M.E.; Joel, D.D. (Brookhaven National Lab., Upton, NY). *Proceedings of the Society for Experimental Biology and Medicine;* No. 1, 112-119(May 1986).

Single doses of ^{7}Be-labeled carbon particles prepared by proton bombardment of carbon black were administered by gavage to weanling (4 weeks) and aged (18 monthy) mice. Body distribution of ^{7}Be radioactivity was determined 4 hr and 1, 2, 5, and 14 days later. The results were compared with those obtained after administration of a solution of ^{7}BeCl2. ^{7}Be radioactivity in nonintestinal tissues was 17-58 times greater in mice gavaged with the soluble salt than in those gavaged with the particles, indicating that particle-bound ^{7}Be was well confined to the gastrointestinal tract. Upper limits of the amount of labeled carbon remaining in intestinal Peyer's patches were as follows: 1 day: weanling, 1.8 X 10(-3)%, old, 5.5 X 10(-3)%; 15 days: weanling, 3.3 X 10(-5)%, old, 8.4 X 10(-5)%. The particles are potentially useful as models for diesel emissions or other particulate pollutants.

38929 Appearance and accumulation of C_4 carbon pathway enzymes in developing maize leaves and differentiating maize A188 callus. Aoyagi, K.; Bassham, J.A. (Lawrence Berkeley Lab., CA). *Plant Physiology;* 80: No. 2, 322-333(Feb 1986). Contract AC03-76SF00098.

Regenerating maize A188 tissue cultures were examined for the presence of enzymes involved in C_4 photosynthesis, for cell morphology, and for ^{14}C labeling kinetics to study the implementation of this pathway during plant development. For comparison, sections of maize seedling leaves were examined. Protein blot analysis using antibodies to leaf enzymes showed a different profile of these enzymes during the early stages of shoot regeneration from callus from the closely-coordinated profile observed in seedling leaves. Pyruvate orthophosphate dikinase (PPDK) (EC 2.7.9.1) and phosphoenolpyruvate carboxylase (PEPC) (EC 4.1.1.31) were found in nonchlorophyllous callus while ribulose 1,5-bisphosphate carboxylase (RuBPC, EC 4.1.1.39) and malic enzyme, NADP-specific (ME-NADP) (EC 1.3.1.37) were not detectable until later. Enzyme activity assays showed the presence of ME-NADP as well as PEPC and PPDK in nonchlorophyllous callus. However, the activities of ME-NADP and PEPC had properties similar to those of the enzymes from C_3 leaves and from etiolated C_4 leaf tissues, but differing from the corresponding enzymes in the mature leaf. Immunoprecipitation of in vitro translation products of poly(A)RNA extracted from embryoid-forming callus showed both the 110 kilodalton precursor to chloroplast PPDK and the 94 kilodalton polypeptide. Therefore, the chloroplast tye of PPDK mRNA is present prior to the appearance of leaf morphology. Analysis of the labeled products of $^{14}CO_2$ fixation by nonchlorophyllous calli indicated β-carboxylation to give acids of the tricarboxylic acid cycle, but no incorporation into phosphoglycerate. With greening of the callus, some incorporation into phosphoglycerate and sugar phosphates occurred, and this increased in shoots as they developed, although with older shoots the increase in β-carboxylation products was even greater.

38930 Association of the chloroplastic respiratory and photosynthetic electron transport chains of Chlamydomonas reinhardii with photoreduction and the oxyhydrogen reaction. Maione, T.E.; Gibbs, M. (Brandeis Univ., Waltham, MA). *Plant Physiology;* 80: No. 2, 364-368(Feb 1986). Contract AC02-76ER03231.

The hydrogenase-dependent processes, photoreduction and the dark oxyhydrogen reaction, both of which can support CO_2 assimilation, were compared with aerobic photosynthesis and respiration for their sensitivity to electron transport inhibitors in cells and intact chloroplasts of Chlamydomonas reinhardii 11-32/6. Photoreduction but no photosynthesis was inhibited in chloroplasts and the oxyhydrogen reaction detected only in cells was inhibited up to 75 and 90%, respectively, by 150 micromolar rotenone, indicating the involvement of a NAD(P)H-plastoquinone oxidoreductase in the hydrogen utilizing pathways. The oxyhydrogen reaction coupled to CO_2 fixation was inhibited more than 95% by 10 micromolar 2,5 - dibromo - 3 - methyl - 6 - isopropyl - p - benzoquinone (DBMIB), a concentration which did not affect respiratory activity. In cells, both photoreduction and the oxyhydrogen reaction exhibited a similar sensitivity to salicylhydroxamic acid (SHAM) showing approximately 90% inhibition by 7 millimolar concentration. Photosynthesis was inhibited only 30% by the same concentration of SHAM. Antimycin A (18 micromolar, 10 micrograms per milliliter) inhibited both photoreduction (80%) and the oxyhydrogen reaction (92%) in cells with the oxyhydrogen reaction being approximately 10 times more sensitive to lower concentrations of the inhibitor. Antimycin A at 18 micromolar concentration did not inhibit photosynthetic CO_2 fixation unless the cells were adapted to an atmosphere of N_2 and the reaction conducted anaerobically. Photosynthesis, photoreduction, and the oxyhydrogen reaction coupled to CO_2 fixation were all inhibited greater than 90% by 10 micromolar carbonylcyanide-p-trifluoromethoxyphenylhydrazone. ATP added to chloroplasts adapted to an atmosphere of H_2 could support CO_2 uptake in the dark.

38931 Alternative respiratory path capacity in plant mitochondria: effect of growth temperature, the electrochemical gradient, and assay pH. Elthon, T.E.; Stewart, C.R.; McCoy, C.A.; Bonner, W.D. Jr. (Univ. of Pennsylvania, Philadelphia). *Plant Physiology;* 80: No. 2, 378-383(Feb 1986). Contract AC02-82ER12028.

Influence of growth temperature on the capacity of the mitochondrial alternative pathway of electron transport was investigated using etiolated corn (Zea mays L.) seedlings. These seedlings were grown to comparable size in either a warm (30°C) or a cold (13°C) temperature regime, and then their respiration rates were measured as O_2 uptake at 25°C. The capacity of the alternative pathway (KCN-insensitive O_2 uptake) was found essentially to double in shoots of cold-grown seedlings. When mitochondria were isolated from the shoots a greater potential for flow through the alternative path was observed in mitochondria from the cold-grown seedlings with all substrates used (an average increase of 84%). Using exogenous NADH as the substrate, the effect of the electrochemical gradient on measurable capacities of the cytochrome and alternative pathways was investigated in mitochondria from both etiolated seedlings and thermogenic spadices. In corn shoot and mung bean (Vigna radiata L.) hypocotyl mitochondria increased flow through the cytochrome chain in the absence of the electrochemical gradient was found not to influence the potential for flow through the alternative path. However, in mitochondria from skunk cabbage (Symplocarpus foetidus L.) and voodoo lily (Sauromatum gutatum Schott) spadices increased flow through the cytochrome chain in the absence of the gradient occurred at the expense of flow through the alternative pathway. This experiment also revealed that the potential for respiratory control is largely dependent upon the assay pH.

38932 Calcium transport in tonoplast and endoplasmic reticulum vesicles isolated from cultured carrot cells. Bush, D.R.; Sze, H. (Univ. of Maryland, College Park). *Plant Physiology;* 80: No. 2, 549-555(Feb 1986). Contract AS05-82ER13015.

Two active calcium (Ca^{2+}) transport systems have been identified and partially characterized in membrane vesicles isolated from cultured carrot cells (Daucus carota Danvers). Both transport systems required MgATP for activity and were enhanced by 10 millimolar oxalate. Ca^{2+} transport in membrane vesicles derived from isolated vacuoles equilibrated at 1.10 grams per cubic centimeter and comigrated with Cl^--stimulated, NO_3^--inhibited ATPase activity on sucrose density gradients. Ca^{2+} transport in this system was insensitive to vanadate, but was inhibited by nitrate, carbonyl

cyanide-m-chlorophenylhydrazone (CCCP), N,N'-dicyclohexylcarbodiimide (DCCD), and 4,4-diisothiocyano-2,2'-stilbene disulfonic acid (DIDS). The K/sub m/ for MgATP and Ca^{2+} were 0.1 mM and 21 micromolar, respectively. The predominant Ca^{2+} transport system detectable in microsomal membrane preparations equilibrated at a density of 1.13 grams per cubic centimeter and comigrated with the endoplasmic reticulum (ER) marker, antimycin A-insensitive NADH-dependent cytochrome c reductase. Ca^{2+} transport activity and the ER marker also shifted in parallel in ER shifting experiments. This transport system was inhibited by vanadate (I_{50} = 12 micromolar) and was insensitive to nitrate, CCCP, DCCD, and DIDS. Transport exhibited cooperative MgATP dependent kinetica. Ca^{2+} dependent kinetics were complex with an apparent K/sub m/ ranging from 0.7 to 2 micromolar. We conclude that the vacuolar-derived system is a Ca^{2+}/H^{+} antiport located on the tonoplast and that the microsomal transport system is a Ca,Mg-ATPase enriched on the ER. These two Ca^{2+} transport systems are proposed to restore and maintain cytoplasmic Ca^{2+} homeostasis under changing cellular and environmental conditions.

38933 Cyclic and noncyclic photophosphorylation in isolated guard cell chloroplasts from Vicia faba L. Shimazaki, K.; Zeiger, E. (Stanford Univ., CA). *Plant Physiology;* **78**: No. 2, 211-214(Jun 1985).

High rates of both cyclic and noncyclic photophosphorylation were measured in chloroplast lamellae isolated from purified guard cell protoplasts from Vicia Faba L. Typical rates of light-dependent incorporation of ^{32}P into ATP were 100 and 190 micromoles ATP per milligram chlorophyll per hour for noncyclic (water to ferricyanide) and cyclic (phenazine methosulfate) photophosphorylation, respectively. These rates were 50 to 80% of those observed with mesophyll chloroplasts. Noncyclic photophosphorylation in guard cell chloroplasts was completely inhibited by 3-(3,4-dichlorophenyl)-1,1-dimethylurea supporting the notion that photophosphorylation is coupled to linear electron flow from photosystem II to photosystem I. Several lines of evidence indicated that contamination by mesophyll chloroplasts cannot account for the observed photophosphorylation rates. A comparison of the photon fluence dependence of noncyclic photophosphorylation in mesophyll and guard cell chloroplasts showed significant differences between the two preparations, with half saturation at 0.04 and 0.08 millimole per square meter per second, respectively.

38934 Cell wall yield properties of growing tissue: evaluation by in vivo stress relaxation. Cosgrove, D.J. (Pennsylvania State Univ., University Park). *Plant Physiology;* **78**: No. 2, 347-356(Jun 1985).

Growing pea stem tissue, when isolated from an external supply of water, undergoes stress relaxation because of continued loosening of the cell wall. A theoretical analysis is presented to show that such stress relaxation should result in an exponential decrease in turgor pressure down to the yield threshold (Y), with a rate constant given by phi ϵ where phi is the metabolically maintained irreversible extensibility of the cell wall and ϵ is the volumetric elastic modulus of the cell. Stress relaxation was measured in pea (Pisum sativus L.) stem segments using the pressure microprobe technique. From the rate of stress relaxation, phi of segments pretreated with water was calculated to be 0.08 per megapascal per hour while that of auxin-pretreated tissue was 0.24 per megapascal per hour. These values agreed closely with estimates of phi made by a steady-state technique. The yield threshold (0.29 megapascal) was not affected by auxin. A theoretical analysis is also presented to show that the tissue hydraulic conductance may be estimated from the T/sub 1/2/ of tissue swelling. Experimentally, pea stems had a swelling T/sub 1/2/ of 2.0 minutes, corresponding to a relative hydraulic conductance of about 2.0 per megapascal per hour. This value is at least 8 times larger than phi. From these data and from computer modeling, it appears that the radial gradient in water potential which sustains water uptake in growing pea segments is small (0.04 megapascal). This means that hydraulic conductance does not substantially restrict growth. The results also demonstrate that the stimulation of growth by auxin can be entirely accounted for by the change in phi.

38935 Ammonium release by juveniles and adult females of the subtropical marine copepod Eucalanus pileatus. Paffenhoefer, G.A.; Gardner, W.S. (Skidaway Institute of Oceanography, Savannah, GA). *Journal of Plankton Research;* **6**: No. 3, 505-513(1984). Contract AS09-76EV00936.

Release rates of ammonium by nauplii, copepodid stages (CII and CIV) and adult females of the marine copepod Eucalanus pileatus at 0.1 and 3.0 $mm^3\ l^{-1}$ of the diatom Thalassiosira weissflogii were determined at 20°C. When food was abundant, animals of all stages released ammonium at similar rates per unit ash-free dry weight [24-35 nmol NH_4 (mg AFDW)$^{-1}$ h^{-1} on average]. At low food levels, CIVs and adult females released ammonium significantly more slowly than did the nauplii or CIIs [28 and 24 versus 51 and 50 nmoles (mg AFDW)$^{-1}$ h^{-1}]. Because they weighed less (50%), low-food nauplii and CIIs had higher calculated weight-specific excretion rates, than high-food ones of the same stage but release rates per copepod were similar in the two food regimens. In contrast to the early life stages, the CIVs and adult females released less ammonium per copepod in the low-food than in the high-food environment.

38936 Nickel. Sunderman, F.W. Jr. pp 279-306 of Hazardous metals in human toxicology. Vercruysse, A. (ed.). Amsterdam, Netherlands; Elsevier Science Publishers B.V. (1984).

The determination of nickel in biological materials has been reviewed, with emphasis on the following topics: precautions for preventing nickel contamination during specimen collection and processing; preliminary steps for oxidation or removal of organic matter; concentration and separation procedures; instrumental methods for quantitation of nickel; reference values for nickel concentrations in human body fluids, tissues and excreta; and nickel concentrations in urine specimens from workers in various occupational groups. Electrothermal atomic-absorption spectrophotometry (EAAS) is currently the most sensitive, convenient and reliable technique for the determination of nickel in biological materials, EAAS is rivalled in sensitivity by three other techniques: differential pulse polarography, particle-induced x-ray emission spectrometry and gas chromatography with electron-capture detection. With further refinements, each of these techniques should be suitable for clinical applications. Combination of isotope-dilution mass spectrometry with the gas chromatographic separation of volatile nickel chelates may eventually become the definitive method for the determination of nickel to biological materials. 114 references, 10 tables.

5506 Medicine

REFER ALSO TO CITATION(S) 38479

38937 (DOE/EV/04318—6) Preparation of gallium-68 radiopharmaceuticals for positron tomography. Progress report, November 1, 1983-May 31, 1986. Welch, M.J. (Washington Univ., St. Louis, MO (USA). Edward Mallinckrodt Inst. of Radiology). May 1986. Contract AC02-77EV04318. 23p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011283.

The work described in this paper centers on the development and assessment of an improved germanium-68/gallium-68 generator, the testing and evaluation of simple germanium/gallium compounds for use with PET, and on methods of attaching gallium and indium to proteins for use with PET as well as indium-111 and conventional images. This work has expanded to use this technology with monoclonal antibodies. We are also studying the mechanisms and stability of binding of these metals to these modified proteins. The syntheses and assessment of new ligands, specifically aimed at measurement of myocardial and brain blood flow are also described. 7 figs., 11 tabs.

38938 **(DOE/EV/04969—T2) [Myocardinal perfusion scintigraphy using a new technique, the mesh chamber]. Second year progress report, 1980.** (Massachusetts Inst. of Tech., Cambridge (USA)). 1980. Contract AC02-78EV04969. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011573.

Tests of small meshes with multi-wire proportional chamber readout gave efficiencies for the detection of annihilation radiation which corresponded to those calculated. Our idea for using an X-Y plotter to put down the wire worked out well. This gave us fair assurance of the success of the chamber for two dimensional pictures. 4 figs.

5507 Microbiology

REFER ALSO TO CITATION(S) 37424, 37425, 37427, 37428

5508 Morphology

REFER ALSO TO CITATION(S) 37719

5509 Pathology

38939 **(AD-A—165845/9/XAB) Studies on the immunochemical techniques for detection of selected fungal and dinoflagellate toxins. Annual progress report No. 2, 1 August 1982-31 July 1983.** Chu, F.S. (Wisconsin Univ., Madison (USA)). 15 Aug 1983. 30p. NTIS, PC A03/MF A01.

During the second year (August 1, 1982 to July 31, 1983), conditions for improving antibody production against T-2 toxin were studied. T-2 HS-BSA which has 10-15 moles of T-2 per mole of BSA was found to be a better immunogen than T-2-HG-BSA. Antibody titers as high as 11,000-14,000 were obtained from rabbits after repeated booster injections. High specific radioactive T-2, DAS, DOVE were prepared. With combination of the high specific radioactive T-2 toxin and high titer antibody, as little as 25 pg of T-2 toxin can be detected by the RIA in each assay. An indirect ELISA which permits detection of 0.2-1 ppb of T-2 toxin in urine, serum and milk was also established. Antibody against T-2 toxin was used to localize T-2 toxin in different tissues and organs of mice by an immunohistochemical technique. A collaborative study with Dr. Hunter revealed that antibody titers of T-2 toxin increased drastically in an immunomodulation system in mice. Titers as high as 50,000 were obtained in mice 10 days after immunization with T-2-HS-IgG (goat). Antibodies against diacetoxyscirpenol (DAS), and deoxyverrucarol (DOVE) were obtained from rabbits after immunizing with DAS-hemisuccinate (HS)-BSA, DAS-hemiglutarate (HG)-BSA and DOVE-HS-BSA. DAS-HG-BSA was found to be a better immunogen than DAS-HS-BSA for the production of antibody against DAS. The antibody for DAS is most specific for DAS. However, DOVE antidbodies were found to be less specific. Radioimmunoassays for both DAS and DOVE were established, and the detection limits were found.

38940 **(AD-A—166012/5/XAB) Pharmacological management of sepsis.** Fletcher, J.R. (Naval Medical Research Inst., Bethesda, MD (USA)). 1985. 9p. (NMRI—85-97). NTIS, PC A02/MF A01.

Systemic sepsis continues to be the most-difficult management problem in caring for the combat casualty. The complications of sepsis pervade all areas of injury to soldiers in the field, whether it is mechanical (missiles), thermal (burns), chemical, biological, or radiation injury. With the advent of tactical nuclear weapons, the problem of sepsis will be much higher in future wars than has previously been experienced through the world. The purpose of this chapter is a) to review the data suggesting pharmacological agents that may benefit the septic patient, and b) to emphasize the adjunctive therapies that should be explored in clinical trials. The pharmacological management of sepsis remains controversial. Most of the drugs utilized clinically treat the symptoms of the disease and are not necessarily directed at fundamental mechanisms that are known to be present in sepsis. A broad data base is emerging, indicating that NSAID should be used in human clinical trials. Prostaglandins are sensitive indicators of cellular injury and may be mediators for a number of vasoactive chemicals. Opiate antagonists and calcium channel blockers require more in-depth data; however, recent studies generate excitement for their potential use in the critically ill patient. Pharmacological effects of antibiotics, in concert with other drugs, suggest an entirely new approach to pharmacological treatment in sepsis. There is no doubt that new treatment modalities or adjunctive therapies must be utilized to alter the poor prognosis of severe sepsis that we have observed in the past 4 decades.

38941 **(AD-A—166343/4/XAB) Pathologic findings in laboratory animals exposed to hydrocarbon fuels of military interest.** Bruner, R.H. (Naval Medical Research Inst., Bethesda, MD (USA)). 1984. 9p. (NMRI—84-76). NTIS, PC A02/MF A01.

Male and female Fischer-344 rats and female C57/BL6 mice were subjected to subchronic and chronic inhalation exposures to a variety of distillate and synthetic hydrocarbon fuels of military interest. In general, male rats exposed to all agents developed a dose-related nephropathy which was not observed in females, controls, or exposed mice. Kidney lesions consisted of greatly increased cytoplasmic hyaline droplets in proximal tubular epithelium, necrosis of proximal tubular cells, and intratubular plugs of necrotic cell debris at the junction of the outer and inner stripe of the outer medulla. Following exposure, males that were held for lifetime oncogenic evaluation exhibited abundant mineralized casts in medullary tubules, multifocal to diffuse papillary hyperplasia of pelvic urothelium, and accentuated tubular degeneration compatible with progressive nephrosis of old rats. Male rats exposed six hours/day, five days/week for one year to two synthetic hydrocarbon missile fuels had significant increases in renal cell tumors, whereas males exposed for 90 days continuously to various distillate fuels failed to develop increased kidney neoplasia following lifespan observation. The pathogenic mechanisms remain unclear, but it is proposed that kidney changes may be related to an inability of renal tubular cells to efficiently digest resorbed alpha 2u globulin - a special protein of male rats which is synthesized in the liver.

38942 **Hematology of a murine β-thalassemia: a longitudinal study.** Popp, R.A.; Popp, D.M.; Johnson, F.M.; Skow, L.C.; Lewis, S.E. (Oak Ridge National Lab., TN). *Annals of the New York Academy of Sciences;* **445**: 432-444([1986]). Contract AC05-84OR21400.

Mice homozygous for a spontaneous mutation, in which the β-major globin gene is deleted, have clinical symptoms of β-thalassemia. These mice have a hypocellular, hypochromic, microcytic anemia that becomes more severe with increasing age. The defective red cell morphology, decreased osmotic fragility of erythrocytes and shortened red cell life span found in β-thalassemic mice are similar to those observed in human β-thalassemia. Synthesis of β-globin is depressed but not as much as might be expected because the expression of theβ-minor globin gene is enhanced to encode two to three times more globin than in normal mice. Splenomegaly, an enlarged pool of stem cells for erythropoiesis, and iron overloading occur in older mice. The fact that these mice remain moderately healthy makes them a very suitable animal model in which to develop and test alternative techniques of gene therapy that could be successfully applied to the treatment of human thalassemia. Homozygous β-thalassemic mice have large deposits of iron in their tissues, which might make these mice also useful for in vivo tests of the effectiveness and possible long-term side effects for newly developed iron chelators.

5510 Physiological Systems

REFER ALSO TO CITATION(S) 38800

5530 Agriculture And Food Technology

REFER ALSO TO CITATION(S) 38178

38943 **(DOE/BP/13084—2) Pen rearing and imprinting of fall chinook salmon. Final report.** Novotny, J.; Macy, T.L.; Gardenier, J.T. (Fish and Wildlife Service, Cook, WA (USA). Willard Field Station; Fish and Wildlife Service, Vancouver, WA (USA). Vancouver Fishery Assistance Office). May 1986. Contract AI79-83BP13084. 72p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86011726.

Upriver bright fall chinook salmon (Oncorhynchus tshawytscha) are being reared in a backwater and a pond along John Day Reservoir to evaluate the benefits of rearing fish and releasing them off-station compared to traditional hatchery procedures. Fish reared in net pens at a density/feeding combination judged to be the economic optimum of those used during 1984 rearing trials exhibited good growth and smolt development. Poor growth and smolt development was observed in fish reared in a large barrier net, especially during the initial two weeks after stocking. In addition, mortality of fish in the barrier net was high (49%) in relation to any of the other treatments tested thus far. Unfed fish in pens utilized the available natural food base, but zooplankton densities were apparently not sufficient for growth, and may have been marginal for sustenance, especially at higher density. ATPase activities at release were significantly higher in low-density pens than in higher density pens, but development at all densities was retarded when compared with ATPase activities of fed fish. Preliminary cost estimates for producing fish using the rearing strategies developed in the current pen-rearing study compared favorably with the average costs of rearing salmonids in a Northwest hatchery.

38944 **(DOE/BP/16726—1) Fisheries enhancement in the Fish Creek Basin: an evaluation of in-channel and off-channel projects, 1984. Annual report 1984.** Everest, F.H.; Sedell, J.R.; Reeves, G.H.; Wolfe, J. (Forest Service, Corvallis, OR (USA). Forestry Sciences Lab.; Mount Hood National Forest, Estacada, OR (USA). Estacada Ranger District). Jul 1985. Contract AI79-84BP16726. 234p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE86011440.

Construction and evaluation of salmonid habitat improvements on Fish Creek, a tributary of the upper Clackamas River, was continued in fiscal year 1984. Habitat improvement work in the basin is designed to increase the annual number of chinook, coho, and steelhead smolt outmigrants from the basin. The primary objectives include: (1) evaluation and quantification of changes in salmonid spawning and rearing habitat resulting from a variety of habitat improvements; (2) evaluation and quantification of changes in fish populations and biomass resulting from habitat improvements; and (3) evaluation of the cost-effectiveness of habitat improvements developed with BPA and KV funds on Fish Creek.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

REFER ALSO TO CITATION(S) 37589, 37595, 37650, 37653, 37655, 37662, 38762, 38763

38945 **(AD-A—165810/3/XAB) AFRRI (Armed Forces Radiobiology Research Institute). Annual research report, 1 October 1984-30 September 1985.** (Armed Forces Radiobiology Research Inst., Bethesda, MD (USA)). 30 Sep 1985. 101p. (AFRRI-ARR—19). NTIS, PC A06/MF A01.

The Armed Forces Radiobiology Research Inst.(AFRRI) is the primary DOD facility for scientific research in the field of radiobiology and related matters. It conducts applied and basic research that is essential for the operational and medical support of the DOD. The work is carried out by five scientific departments: Behavioral sciences - Effects on ionizing radiation, chemicals, and drugs on performance. Biochemistry - Elucidation of mechanisms of injury, repair, and protection from the effects of ionizing radiation alone or in combination with other agents; development of improved methods to detect and quantify the severity of radiation injury. Experimental Hematology - Investigation of radiation injury of bone marrow; development of therapy for damage from intermediate radiation doses; determination and treatment of injuries caused by combined effects of radiation, blast, and burns. Physiology - Research on cellular, tissue, and whole-animal models to determine physiological and biophysical changes resulting from radiation either alone or in combination with drugs and other chemicals. and Radiation Sciences - Operation, maintenance, and quality control of all AFRRI radiation sources, radiation dosimetry and estimation of tissue doses at various depths in different kinds if tissues; development and use of nuclear medicine and magnetic spectroscopic techniques for determining radiation damage in animals and model systems.

38946 **(DOE/EV/03490—2530) Report of activities 1947-1985.** (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1986. Contract AC02-76EV03490. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011966.

Contract AC02-76EV03490 with the University of Rochester for 38 years funded a program of scientific investigation supporting the requirements and goals of Manhattan District, Atomic Energy Commission and successor organizations, with particular emphasis in development of exposure standards for ionizing and nonionizing radiations, exposure to toxic compounds and dusts, and to the long-term effects of these exposures in biological systems. Over the course of the contract, more than 2000 individual publications resulted as well as several compendia describing toxicity of materials and biological effects of radiation. Nearly 250 Ph.D. degrees were awarded in the fields of radiation biology, physics, and pharmacology/toxicology over that period and greater than 500 Masters degrees in these and subject areas such as industrial hygiene, radiological health, etc.

38947 **(GSF—41/85) Placental transfer of iodine and iodine compounds.** Stieve, F.E.; Zemlin, G.; Griessl, I. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.); Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Strahlenschutz). Nov 1985. 167p. (In German). (GSF-S—1286). NTIS (US Sales Only), PC A08/MF A01. File Number DE86752085.

The following topics are valid for man and mammalians with haemochorial placenta, which are examined up to now: Within several hours after injection of radioactive inorganic iodide-compounds activity can be realized in the fetus. The transfer occurs bidirectionally through the placenta. The concentration of radioactive iodide in the fetal serum exceeds that of the maternal one already a short time after application. Radioactive iodide accumulates in the fetus before its thyroid starts its function and is mainly concentrated in liver and intestine; after starting its function, the fetal thyroid, stores the radioactive iodide at a very high percent rate. During gestation the concentration of radioactive iodide in the fetal thyroid increases and at the end of gestation it can exceed by 3-10 fold that in the maternal thyroid. Single uptake of radioactive iodide leads to a higher activity than chronic uptake. No analogy can be found in the concentration of fetal and maternal radioactive thyroid hormon compounds. A placental permeability for T_4 and T_3 only exists to a very small extent. Resulting from radioactive iodide transfer examinations, good accordance can be found between the individual animal species and man, while data on the passage of radioactive thyroid hormones vary to a small extent between the animal species. (orig./MG).

38948 (INIS-mf—9883) Pathological changes in the rabbit lungs after irradiation and after combined irradiation and hyperthermia. Zinner, M. (Erlangen-Nuernberg Univ., Erlangen (Germany, F.R.). Medizinische Fakultaet). 22 Oct 1984. 70p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752076.

The effects of combined irradiation and hyperthermia and of irradiation alone on normal lung tissue was investigated in rabbits. The animals of both therapy groups were irradiated with 2 Gy five times a week for a 6-week period. The animals of group 1 were additionally exposed to hyperthermia 3 times a week after irradiation. The method applied was the condenser field method (25 to 35 Watt/min). Only the right lung was treated in all animals. The animals were sacrificed 3 months after termination of the therapy, and large-surface lung sections were prepared. The following results were obtained: There is a quantifiable difference in the severeness of fibrosis between groups 1 and 2. Fibrosis was more pronounced in group 1 but the difference was not statistically significant. In both groups, fibrosis was unevenly distributed in the different lung areas. Fibrosis was highest in the ventral and apical regions. These were the regions where the highest local temperature rise was recorded during hyperthermia and where the highest local radiation dose was applied. Histologically, signs of acute inflammatory processes were observed in both groups in parallel to regeneration and repair processes involving neogenesis. (orig./MG).

38949 (PNL—5831) Extremity dosimetry at US Department of Energy facilities. Harty, R.; Reece, W.D.; MacLellan, J.A. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 63p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86012089.

A questionnaire on extremity dosimetry was distributed to DOE facilities along with a questionnaire on beta dosimetry. An informal telephone survey was conducted as a follow-up survey to answer a few additional questions concerning extremity monitoring practices. The responses to the questionnaire and the telephone survey are summarized in this report. Background information, developed from operational experience and a review of the current literature, is presented as a basis for understanding the information obtained by the survey and questionnaire.

38950 (RFP—3878) Comparing two Poisson populations sequentially: an application. Halteman, E.J. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1986. Contract AC04-76DP03533. 6p. (CONF-8604180—1). NTIS, PC A02. File Number DE86009644.

From ASA CO-WYO chapter spring meeting; Boulder, CO, USA (18 Apr 1986).

Rocky Flats Plant in Golden, Colorado monitors each of its employees for radiation exposure. Excess exposure is detected by comparing the means of two Poisson populations. A sequential probability ratio test (SPRT) is proposed as a replacement for the fixed sample normal approximation test. A uniformly most efficient SPRT exists, however logistics suggest using a truncated SPRT. The truncated SPRT is evaluated in detail and shown to possess large potential savings in average time spent by employees in the monitoring process.

38951 Retention of 238Pu-bearing particles by corn plants. Pinder, J.E. 3d.; Doswell, A.C. *Health Physics;* No. 5, 771-776(Nov 1985).

To measure the retention of 238Pu-bearing particulates on plant surfaces, corn plants were exposed to 238Pu deposition in the vicinity of the H-Area nuclear fuel chemical separations facility on the U.S. Department of Energy's Savannah River Plant. Following exposure, plants were removed to an area of lower 238Pu deposition rate and sampled every seven days for 28 days to determine 238Pu retention. To investigate the effects of exposure to wind and precipitation on 238Pu retention, some plants were maintained out of doors while others were maintained in a greenhouse. Plants maintained in the greenhouse showed no statistically significant reduction in 238Pu contents. Plants maintained outside showed 238Pu loss rates consistent with the 14-day retention half-times typically used in radiological assessments. The data analysis of outside plants was complicated by the occurrence of samples with nondetectable 238Pu contents.

38952 Tritium toxicity program in the Medical Department at Brookhaven National Laboratory. Carsten, A.L. (Brookhaven National Lab., Upton, NY). *Annals of the New York Academy of Sciences;* 258-268(1985).

A summary of all the findings to date is given. It appears from this information that it is possible to detect somatic, cytogenetic, and genetic effects resulting from exposures at 33 to 100 times the mpc's for HTO. Similar effects also result from exposure to external gamma rays at an equivalent dose. The reduction in bone marrow cells in animals maintaining normal total cellularity is of interest since it demonstrates both the presence of an effect at the primitive cell level and the animal's ability to compensate for this effect by recruiting stem cells from the G0 resting state. This evidence of damage together with the observed cytogenetic changes leads one to contemplate the possible importance of radiation exposures at these levels for the induction of leukemia or other blood dyscrasias. Studies to investigate this question are now under way. As predicted on the basis of established principles of radiobiology, exposure to tritium beta rays from HTO ingestion results in measurable effects on several animal systems. The importance of position of incorporation of H into molecules of biological importance has not been well defined, nor have the low-dose portions of the dose-response curve for several effects of interest. Experiments designed to address these questions and measure H turnover as a means for analysis of cell kinetics in several systems are now under way.

38953 ^{226}Ra uptake by sagebrush from uniform and nonuniform soil amendments. Simon, S.L.; Fraley, L. Jr. (Colorado State Univ., Fort Collins, CO). *Environmental and Experimental Botany;* 1-8(1985). Contract AC02-79EV10305.

A two-group plant uptake experiment was conducted in which sagebrush seedlings (Artemisia tridentata) were grown in pots containing soil spiked with ^{226}Ra. The objective was to determine the effect of soil tracer amendment configuration on the uptake of ^{226}Ra as determined by the concentration in leaves. The soil in all pots was spiked to contain the same total radioactivity. In one group, the radioactivity was distributed uniformly in the soil. In the other group, the activity was injected into the soil along a narrow vertical line, the site of injection being chosen randomly. The mean ^{226}Ra leaf concentration from each group was 0.8 kBq/kg; however, the coefficient of variation of the leaf concentration from uniformly contaminated soil was 30% as compared to 84% for uptake from injected soil. It was concluded from statistical hypothesis testing that the mean leaf concentration was indistinguishable for the two groups. 20 references, 2 figures, 2 tables.

38954 General discussion on assessment of radiation risks for space flight. Sinclair, W.K.; Fry, R.J.M. (National Council on Radiation Protection and Measurements, Bethesda, MA). *Advances in Space Research;* 4: No. 10, 287-288(1984).

This discussion focuses on several problem areas in relation to the radiation hazards of space flight. A number of biological effects were cited, such as lethality, cell transformation, tumor induction, small colony formation, modification of cell growth rate, etc., in which HZE particles seem to behave in the same way qualitatively as other radiations and in some cases quantitatively. Limitations in the physical description of the radiations in space were discussed with respect to radiation at different locations, with and without shielding, for the purposes of tissue dosimetry, exposure per mission, etc. It was concluded that some dosimetry situations are fairly well documented, including various Apollo and shuttle missions. Approaches to space guidelines involving dose limitations are presented.

5602 Thermal Effects

REFER ALSO TO CITATION(S) 38931

38955 Concomitant changes in high temperature tolerance and heat-shock proteins in desert succulents. Kee, S.C.; Nobel, P.S. (Univ. of California, Los Angeles). *Plant Physiology;* 80: No. 2, 596-598(Feb 1986). Contract AC03-76SF00012.

Raising the day/night air temperatures from 30°C/20°C to 50°C/40°C increases the high temperature tolerated by Agave deserti, Carnegiea gigantea, and Ferocactus acanthodes by 6°C to 8°C; the increase is about half completed in 3 days and fully completed in 10 days. A 25 to 27 kilodalton protein concomitantly accumulates for all three desert succulents upon transfer to 50°C/40°C, while accumulation of other heat heat-shock proteins is species specific. Some of the induced proteins are more abundant at 3 days, while others (including the 25-27 kilodalton protein) remain after completion of high temperature acclimation.

5603 Chemicals Metabolism And Toxicology

REFER ALSO TO CITATION(S) 37278, 37311, 37328, 37386, 37388, 37390, 37473, 37475, 38475, 38515, 38792, 38893, 38898, 38930, 38946

38956 (EPRI-CS/EA/EL—4480, pp 6.20-6.22) **Human health risks from PCB-contaminated mineral oil transformers.** Eschenroeder, A.Q.; Faeder, E.J. Mar 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920219. (CONF-8510293—).

From EPRI polychlorinated biphenyl (PCB) seminar; Seattle, WA, USA (22 Oct 1985).

The human health risks due to the inhalation of combustion products from accidental mineral oil transformer fires occurring outdoors are estimated. Polychlorinated dibenzofurans (PCDFs) are believed to be the principal toxic products of the pyrolysis of PCBs sometimes found as contaminants in transformer mineral oil. The adverse health effects addressed are those attributable to the toxic action of PCDFs inhaled in the neighborhood of the fire. The likelihood of anyone in the neighborhood of the fire receiving even the conservative EPA safe lifetime dose level is less than one in 7,000,000. Therefore, it would appear as if no significant health risk is posed by inhalation exposure to possible PCDF products from mineral oil transformer fires under the system scenario employed in this analysis.

38957 (OEFZS—4339) **Research strategies against forest dieback. Lectures and discussion.** Orthofer, R. (ed.). (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H.). Nov 1985. 112p. (In German). (CONF-8505287—; NU—15/85). Oesterreichisches Forschungszentrum Seibersdorf GmbH .

From 2. workshop of the Austrian research program on forest dieback; Seibersdorf, Austria (7 May 1985).

The report contains an introducing overview of the Austrian research program on forest damages (Waldsterben) and documents the 9 lectures and the discussion of the 2nd joint workshop of the Austrian Federal Ministery of Science and Research and the Austrian Research Center Seibersdorf in May 7th, 1985. The lectures present the proposed strategies for some research fields and a comparison of the Austrian research program with similar programs in other countries, especially the FR Germany. (orig.).

38958 (PNL-SA—13632) **Chemical basis for photomutagenicity in synthetic fuels.** Selby, C.P.; Calkins, J.; Enoch, H.G.; Wright, C.W.; Wilson, B.W. (Pacific Northwest Labs., Richland, WA (USA); Kentucky Univ., Lexington (USA)). Dec 1985. Contract AC06-76RL01830. 14p. (CONF-860425—28). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011132.

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

Photomutagens (chemicals that enhance the mutagenicity of near uv-visible radiation) have been detected in a variety of experimental coal- and oil shale-derived synthetic fuels using S. typhimurium strain TA98 and fluorescent light. In this study, photomutagenic activity was measured among synfuel samples that included crude and hydrotreated shale oil, coal oil distillation fractions, and chemical class fractions of coal and shale oils. Photomutagenic activity was found to increase with increasing boiling point and was cencentrated in fractions enriched in neutral polycyclic aromatic hydrocarbons (PAH). These results point to high molecular weight neutral PAH constitutents as important photomutagenic components among the samples tested. The photomutagenic activities of the materials tested correlate well with the previously reported tumorigenic activities of the same samples on mouse skin but correlate poorly with the previously reported mutagenic activities in the conventional Salmonella/mammalian-microsome mutagenicity test in which neutral PAH fractions were inactive.

38959 (SI-R—800901-9) **Mutagenicity of polycyclic aromatic compounds (PAC), identified in source emissions and ambient air.** Moeller, M.; Hagen, I.; Randahl, T. (Sentralinstitutt for Industriell Forskning, Oslo (Norway)). 1985. 32p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752129.

Several polycyclic aromatic compounds including nitrated and oxygenated derivatives of polycyclic aromatic hydrocarbons were tested for mutagenic activity in the Salmonella/ microsome assay. Among the compounds tested the isomer mix of nitro-1-hydroxypyrenes showed the highest direct mutagenic response in both the Salmonella strain TA98 and TA100. The direct acting mutagenicity of the nitro-1-hydroxypyrene isomer mix was dependent upon reduction of the nitro function as evidenced by the decrease in activity observed with the nitroreductase deficient and arylhydroxylamine estrifying deficient tester strains. The oxygenated derivatives of PAH containing aldehyde or keto groups showed weak or no mutagenic response. In most cases addition of S9 was essential for any mutagenic activity and the strain TA100 was more sensitive than the strain TA98. Within this group, 7H-dibenzo(c,g)fluoren-7-one showed the highest mutagenic effect; 7 and 22 revertants/μg using the strains TA98 and TA100, respectively. 2 appendices describing synthesis of various polycyclic oxigenated mutagens. 3 tables, 9 drawings.

38960 (SI-R—800901-11) **Carcinogenic and mutagenic compounds from energy generation - health effects.** Victorin, K.; Ahlborg, U.G. (Senter for Industriforskning, Oslo (Norway)). Jul 1985. 32p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752495.

A discussion of health effects caused by mutagenic and carcinogenic compouds from various combustion sources is presented. The report concentrates on Sweden and supports the estimate reached by the Swedish cancer committe, that out of a total of 2000 lung cancer cases each year, in Sweden, around 100 would be caused by air pollution. Traffic and residential heating are the dominating sources of mutagenic air pollution in urban areas. 20 references.

38961 (SVC—85.42) **Management of risk for industrial metallic aerosols. In vitro assessment of delivered dose per unit exposure.** Stern, R.M. (Svejsecentralen, Glostrup (Denmark)). 1985. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752100.

For many complex industrial exposures, and for the case of metallic aerosols in particular, causality between adverse health effects and exposures has been demonstrated without characterization of the causative agent beyond the presence of the putative toxic element. For the case of nickel and chromium in particular, both historical human epidemiological and experimental animal data clearly demonstrate an extremely wide range of potencies for complex occupational exposure and for pure substances which have, in one form or other, one of these elements in common. With only few exceptions, current practice for the control of these and most metals is to regulate exposure of the element per se, although hexavalent chromium (CrVI) and soluble (unspecified further) nickel have specific, stringent exposure limits. The mechanisms underlying the variation in potency have been obscure, but it is evident that cumulative exposure to the element is not a reliable index of risk.

38962 **Inhibition of mouse lung tumor development by hyperoxia.** Lindenschmidt, R.C.; Tryka, A.F.; Witschi, H.P. (Oak Ridge National Lab., TN). *Cancer Research;* 1994-2000(Apr 1986).

The hypothesis was tested that continuous hyperoxia would enhance the development of lung tumors in mice. In strain A/J mice treated with a single dose of urethan (1000 mg/kg) and exposed to 70% O2 for 16 wk, an average of 5 tumors per lung developed, whereas in animals kept in air, an average of 20 tumors per lung was found. When the animals were returned to air after oxygen exposure, it was found that a difference of 15 tumors per

lung between the two groups persisted up to 1 yr later, indicating that O2 was tumoricidal. The shortest duration of O2 exposure to be effective was 4 wk, and delay of O2 exposure up to 12 wk after urethan still was effective in reducing the number of developing tumors. Histopathology showed that continued exposure to 70% O2 produced some hyperplasia of the bronchiolar epithelium and only very discrete changes in the pulmonary parenchyma. Analysis of cell proliferation patterns with a continuous [3H]thymidine labeling technique showed a persistent high cell labeling in the bronchiolar epithelium and a temporary increase in alveolar wall cell labeling. Chronic hyperoxia failed to alter the activities of pulmonary superoxide dismutase or glucose-6-phosphate dehydrogenase. Ornithine decarboxylase, on the other hand, was increased as long as the animals remained exposed to oxygen. It was concluded that hyperoxia kills developing tumor cells in mouse lung.

38963 2-Nitrofluoren-9-one: a unique mutagen formed in the photo-oxidation of 2-aminofluorene. Strniste, G.F.; Nickols, J.W.; Okinaka, R.T.; Whaley, T.W. (Los Alamos National Lab., NM). *Carcinogenesis (New York);* No. 3, 499-502(Mar 1986).

Exposure of solutions of 2-aminofluorene (2-AF, dissolved in dimethylsulfoxide) to near ultraviolet light (u.v.a. wavelengths of 320-400 nm) results in the formation of a variety of photo-products, several of which are direct-acting mutagens in the Ames/Salmonella standard-plate assay. Previously published results from our laboratory have described the chemical identification and kinetics of formation of two of these photo-induced mutagens, 2-nitrosofluorene and 2-nitrofluorene. In this report we present recent data concerning the isolation and chemical identification of another mutagenic photoproduct of u.v.a.-irradiated 2-AF, 2-nitrofluoren-9-one (2-NO2F-9-one). Data are also presented concerning the kinetics of phototransformation of 2-aminofluoren-9-one, an early-appearing and predominant photoproduct in u.v.a.-irradiated solutions of 2-AF, into 2-NO2F-9-one. It is well established that N-oxidation is a critical step in the biotransformations (i.e. enzymatic metabolism) of primary aromatic amines into proximate mutagens/carcinogens. In addition to u.v.a.-mediated N-oxidation of aromatic amines, selective ring photo-oxidation can also occur, resulting in, for example, the production of a carbonyl group at the 9-position of the fluorene molecule. The formation of mutagenic 2-NO2F-9-one in the photochemical oxidation of 2-AF appears to be unique to this process.

38964 Studies on the mechanism of regulation of the mRNA level for a soybean storage protein subunit by exogenous L-methionine. Holowach, L.P.; Madison, J.T.; Thompson, J.F. (Dept. of Agriculture, Ithaca, NY). *Plant Physiology;* **80**: No. 2, 561-567(Feb 1986). Contract AI05-83ER13114.

In previous studies we have shown that when soybean (Glycine max L. Merrill cv Provar) cotyledons are cultured in medium supplemented with L-methionine, the β-subunit of 7S protein and β-mRNA are absent. We have carried our further studies on the mechanism of the methionine action. In one experiment, cotyledons were cultured for 16 days with or without methionine. After 4 days, some cotyledons were transferred from methionine-supplemented to basal (no methionine) medium and vice versa. In basal medium, β-subunit was detected at 4 days whereas in methionine-supplemented medium, no β-subunit was present. When cotyledons were transferred from basal to methionine-supplemented medium, the β-subunit increased within a 4 day period and then remained constant (on a per cotyledon basis). This result indicated that methionine was not acting by accelerating the degradation of the β-subunit. Four days after transfer from supplemented to basal medium cotyledons contained β-subunit, thus demonstrating that the inhibition was reversible. During this time, the uncombined methionine declined from 7 to 1.5 μmoles methionine per gram fresh weight. When β-mRNA was measured by in vitro translation, functional β-mRNA was absent in tissue that was not accumulating β-subunit. The messenger RNA for the β-subunit had a half-life of about 1 day in the presence of methionine. Hybridization of cotyledon mRNA with cDNA complementary to β-mRNA revealed that the 1700 nucleotide β-mRNA was not present in supplemented cotyledons. Thus, expression of the β-subunit gene is controlled at the level of transcription, RNA processing, or RNA turnover, rather than at the level of translation.

38965 Health effects of diesel exhaust: a case study in risk assessment. McClellan, R.O. (Inhalation Toxicology Research Institute, Albuquerque, NM). *American Industrial Hygiene Association Journal;* **47**: No. 1, 1-13(Jan 1986). Contract AC04-76EV01013.

From American industrial hygiene conference; Dallas, TX, USA (18-23 May 1986).

The increased emphasis given to balancing costs and benefits in developing regulations for factors influencing human health has provided a strong impetus for development of a more formalized approach to risk assessment. Exposure to diesel exhaust gases is used as an example in order to examine the components of the risk assessment process as it is presently understood. The components of risk assessment are hazard identification, exposure-dose-response assessment, and exposure assessment. Risk is then characterized. Based on these studies, risk management options are defined, and the consequences of options are delineated, including public health, economic costs, and social and political factors. 28 references, 11 figures, 5 tables.

38966 Effects of inhaled diesel exhaust on immune responses after lung immunization. Bice, D.E.; Mauderly, J.L.; Jones, R.K.; McClellan, R.O. (Inhalation Toxicology Research Institute, Albuquerque, NM). *Fundamental and Applied Toxicology;* 1075-1086(Dec 1985).

The inhalation of diesel exhaust particles and the accumulation of these particles in the lung-associated lymph nodes could alter the development of immune responses after lung immunization. To study this possibility, Fischer 344 rats and CD-1 mice were exposed to three levels of diesel exhaust (nominal concentration--7000, 3500, or 350 micrograms particles/m3). Chamber controls and exposed animals were immunized by intratracheal instillation of sheep red blood cells (SRBC) after 6, 12, 18, and 24 months of exposure. The number of anti-SRBC IgM antibody-forming cells (AFC) in the lung-associated lymph nodes and spleen was evaluated after immunization. The lung-associated lymph nodes from rats and mice exposed to the high levels of diesel exhaust were black with accumulated diesel particles, and the number of lymphoid cells was significantly elevated at each sacrifice time, while rats exposed to the medium level of diesel exhaust also had elevated numbers of cells in these tissues at 12, 18, and 24 months of exposure. The total number of AFC in the lung-associated lymph nodes was significantly elevated (p less than 0.05) in rats exposed to medium and high levels of diesel exhaust, but no significant effects were observed in exposed mice. Data expressed as AFC/10(6) lymphoid cells in rats and mice, and the level of specific IgM, IgG, or IgA antibody in rat sera were not significantly altered. We conclude that the increased cellularity, and the presence of diesel particles in the lung-associated lymph nodes, had a minimal effect on the immune and antigen filtration functions of these tissues.

38967 Correlation of the octanol/water partition coefficient with clearance halftimes of intratracheally instilled aromatic hydrocarbons in rats. Bond, J.A.; Baker, S.M.; Bechtold, W.E. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM, USA. Inhalation Toxicology Research Inst.). *Toxicology;* **36**: No. 4, 285-295(Sep 1985).

Studies on the lung retention of polycyclic aromatic hydrocarbons (PAH) after inhalation have indicated that, in general, the PAH are rapidly cleared from the respiratory tract. Clearance of the PAH from the lungs is best described as bi-phasic, with the long-term component of the clearance curve having a half-time of greater than 24 h. The purpose of this study was to determine whether a relationship exists between the lipophilicity (as measured by the octanol/water partition coefficient, P) of various PAH and the short-term and long-term clearance half-times of PAH in rat lungs. Female F344/Crl rats were administered intratracheally 1 nmol of ^{14}C-labelled anthracene (AN), benz (a) anthracene (BA), 1-nitropyrene (NP), 6-nitrobenzo (a) pyrene (6-NBP), or dibenzo (c, g) carbazole (DBC). At various times after instillation rats were sacrificed and the amount of ^{14}C from rat lungs following instillation of the different PAH was biphasic. In all cases, greater than 85% of the initial dose instilled was cleared with a half-time of less than 1 h. The half-times for clearance of the residual ^{14}C (1-15% of the dose) were 26, 30, 36, 53 and 63 h for AN, NP, 6-NBP, BA and

DCB, respectively. The log of the octanol-water partition coefficients for the different PAH examined ranged from 4.1 (AN) to 6.05 (DBC). Plots of the octanol/water coefficients vs. the long-term clearance half-time for the PAH indicated a linear correlation ($p<0.001$; $r^2=0.96$). The results from this study indicate that the greater the lipophilicity of the PAH, the slower the long-term clearance of a small fraction (1-15%) of PAH from rat lungs. These data suggest that predictions of long-term lung clearance can be made for PAH with log octanol-water partition coefficients between 4 and 6. 29 refs.

38968 **Conformations of DNA adducts with polycyclic aromatic carcinogens.** Broyde, S.; Hingerty, B. (New York Univ., NY). pp 153-171 of Molecular basis of cancer. Part A: macromolecular structure, carcinogens and oncogenes. New York, NY; Alan R. Liss, Inc. (1985). Contract AC02-81ER60015;AC05-84OR21400.

Given the likelihood that a chemical carcinogen initiates cancer via a mutation, attempts were made to try to understand how such mutations are produced. A number of steps take place following the entry of a chemical into a cell, which determine whether or not that substance is mutagenic. These include various pathways of metabolic activation, the reactions of the metabolites with DNA, and the interaction of each of the adducts that are formed with the replication apparatus and various repair systems. The response of the replicative and repair enzymes to each damaging event in DNA is a critical factor in mutagenesis and cell transformation, one which is governed, the authors believe, by the local conformation of the modified DNA. A particular carcinogen may form a number of adducts with DNA, only one of which may be the critical transforming moiety. The authors are interested in learning whether a unique conformation distinguishes mutagenic and carcinogenic lesions from benign ones. Accordingly, attention has been centered on the influence of covalently linked polycyclic aromatic amines and hydrocarbons on DNA conformation. A large number of trial starting conformations, ranging from 500 to 4000 are employed, yielding a satisfactory survey of conformation space for the modified deoxydinucleoside monophosphate. The authors have been studying the dCpdG sequence. They have been investigating adducts with the aromatic amines acetylaminofluorene (AAF) and 4-aminobiphenyl (ABP), as well as the aromatic hydrocarbon benzo[a]pyrene-7,8-diol-9,10-epoxide.

38969 **Effects of diethyldithiocarbamate and nickel chloride on glutathione and trace metal concentrations in rat liver.** Sunderman, F.W. Jr.; Zaharia, O.; Reid, M.C.; Belliveau, J.F.; O'Leary, G.P. Jr.; Griffin, H. (Univ. of Connecticut, Farmington). *Toxicology;* 32: 11-21(1984).

Concentrations of reduced glutathione (GSH) and oxidized glutathione (GSSG) and 4 trace metals (Ni, Cu, Mn, Zn) were measured in livers from rats treated with sodium diethyldithiocarbamate (DDC, 0.67 or 1.33 mmol/kg, i.m.) and $NiCl_2$ (0.25 or 0.50 mmol/kg, s.c.), singly or in combination. In rats treated with DDC or $NiCl_2$, singly, hepatic GSH was diminished at 4 h and returned to control levels (or slightly above) at 17 h. In rats that received DDC plus $NiCl_2$, hepatic GSH was not diminished at 4 h and was increased 1.4-1.8-fold at 17 h. Hepatic GSSG was diminished at 4 h after $NiCl_2$ treatment and returned to control values at 17 h; hepatic GSSG did not differ from control values at 4 h or 17 h after treatment with DDC, alone or combined with $NiCl_2$. Hepatic Ni was below the detection limit (~20 nmol/g) in control and DDC-treated rats; hepatic Ni was increased to 53 +/- 26 (S.D.) nmol/g at 17 h after treatment with $NiCl_2$ alone, and was increased 6-fold (308 +/- 63 nmol/g) in rats that received Ni plus DDC. Under the same conditions, hepatic Zn was increased 33% or 41%, respectively, in rats that received $NiCl_2$ or DDC, singly, and was not further increased by combined treatment; hepatic Cu and Mn concentrations were unaffected by $NiCl_2$ or DDC, singly, but were diminished in rats that received $NiCl_2$ and DDC. This study suggests: (a) that increased hepatic uptake of Ni is largely responsible for the synergistic induction of heme oxygenase activity in rats treated with $NiCl_2$ and DDC; and (b) that increased hepatic uptake of Zn contributes to the induction of hepatic metallothionein by $NiCl_2$ and DDC. 34 references, 2 tables.

38970 **Effect of ionic interaction of chlorode-borate and iodide-borate on their absorption by Lemna minor L.** Thellier, M.; Ayadi, A.; Tromeur, C. *Comptes Rendus des Seances de l'Academie des Sciences, Serie 3;* 265: 1687-1690(27 Nov 1967). (In French).

The effect of borate ions on the absorption of chloride and iodide ions by Lemna minor was studied by using the radioactive tracers Cl-36 at 23°C with an illumination of 8000 Lux and I-131 at 25.5 C with 600 Lux. The absorbed quantities of the tracer elements were measured with a Geiger counter. The concentrations of sodium chloride solutions tested ranged from 0.055 to 1 mM, those of potassium iodide from 0.04 to 4 mM. While the presence of borate ions in the test solutions of NaCl inhibited the absorption of Cl ions by Lemna minor, only a mild inhibition or none at all was noted in the case of the absorption of I ions. Because of the difference of the cations (sodium in the case of Cl, potassium in the case of I) no direct comparison can be drawn between the absorption of the two halogens. The absorption of I by the plant is thought to proceed by a much simpler mechanism than that of Cl.

5604 Other Environmental Pollutant Effects

REFER ALSO TO CITATION(S) 38788

38971 **(PB—86-185535/XAB) Circulating antibody response of mice exposed to 9-GHz pulsed microwave radiation.** Liddle, C.G.; Putnam, J.P.; Lewter, O.H.; West, M.; Morrow, G. (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). 1986. 6p. (EPA/600/J—86/023). NTIS, PC A02/MF A01.

Female CD-1 mice immunized against the bacterium Streptococcus pneumoniae type III were exposed to 9-GHz pulsed microwaves (pulse repetition rate 970-1.000, pulse width 1.0 micro seconds, peak power 1 W/cm2) at an average incident power density of 1 mW/sq.cm. (calculated SAR = 0.47 W/kg) for 2 h per day for 5 days. Circulating antibody titers for the microwave-exposed animals were not significantly different from those of the sham-irradiated animals, and there were no differences in any of the hematological parameters analyzed, indicating that 9-GHz pulsed microwaves at 1 mW/sq.cm. do not alter the immune response of mice immunized against S pneumoniae.

38972 **(PB—86-187192/XAB) Effect of 9.6-GHz pulsed microwaves on the orb web spinning ability of the cross spider (Araneus diadematus).** Liddle, C.G.; Putnam, J.P.; Lewter, O.L.; Lewis, J.Y.; Bell, B. (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). 1986. 8p. (EPA/600/J—86/022). NTIS, PC A02/MF A01.

Eight cross spiders (Araneus diadematus) were exposed overnight (16 h) during web-building activity to pulsed 9.6-GHz microwaves at average power densities of 10, 1, and 0.1 mW/sq. cm. (estimated SARs 40, 4, and 0.4 mW/g). Under these conditions, 9.6-GHz pulsed microwaves did not affect the web-spinning ability of the cross spider.

38973 **(PB—86-190113/XAB) Improved technique for monitoring electrocardiograms during exposure to radio-frequency radiation.** Watkinson, W.P.; Gordon, C.J. (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). 1986. 7p. (EPA/600/J—86/033). NTIS, PC A02/MF A01.

Studies were conducted which examined the effects of radio frequency (RF) radiation on heart rate (HR), deep body temperature (TEMP), and electrocardiographic (ECG) waveform parameters in anesthetized rats. One group of animals was exposed to two power levels of continuous wave RF radiation averaging 1.0 and 7.4 W/kg at a frequency of 600 MHz. A second group of animals, treated identically but not exposed to RF radiation, served as a control. The electrodes used to monitor the ECG during RF exposure were fabricated using carbon-loaded Teflon wire, a semiconductor material that does not perturb the RF field. Analyses of the ECG were conducted using a recently developed computer-assisted procedure which quantitates HR and waveform intervals over 25-

40 individual ECG complexes. There were no artifacts or arrhythmias in the ECGs of the animals exposed to RF radiation. There was a significant linear correlation between HR and TEMP in the RF-exposed group which was not present in the control group.

38974 **(PB—86-193695/XAB) Nonelectromagnetic factors influence behavioral effects of microwave exposures.** Gage, M.I. (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). May 1986. 25p. (EPA/600/D—86/098). NTIS, PC A02/MF A01.

Alteration in animal behavior both during and after microwave irradiation is well documented. This report reviews a number of experiments in which specific behavioral effects in laboratory rodents were quantitatively changed by aspects of the exposure such as ambient air temperature, duration of the exposure, and orientation in the field while exposure parameters of 2450 MHz (CW) electromagnetic radiation were kept constant. Operant response rates were reduced and response durations were increased after overnight irradiations with 10 or 15 mW/sq.cm. when ambient air temperature during the exposure was 28 C but not when the temperature was 22 C. Operant behavior of rats, which was reduced by 50% or more after an overnight irradiation, was not reduced after a similar exposure of only 55 min. In another experiment, response rates declined with time after exposures lasting 4 hrs., did not decline further after exposures lasting from 4 to 8 hrs., but did decline further after exposures lasting longer than 8 hrs.

57 HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 38858

38975 **(GAO/RCED—86-121) Aviation safety. Serious problems concerning the Air Traffic Control work force.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). Mar 1986. 111p. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877. File Number TI86901386.

Report to the Secretary of Transportation.

This report provides the results of an extensive study of the air traffic control work force and includes conclusions and recommendations. The report shows that the Federal Aviation Administration (FAA) has not met its goals for fully qualified (FPL) controllers at many major facilities, and that the growth in air traffic activity as caused controller work load to reach a point where controllers are stretched too thin. Controllers and their supervisors have expressed serious concerns about their ability to continue to maintain the proper margin of safety. We recommend that FAA impose restrictions on air traffic until both the number of FPL controllers and overtime requirements meet FAA's goals. Problems relating to both the number of FPLs and overtime are most acute at the air route traffic control centers and FAA must recognize this in deciding what restrictions to impose.

38976 **(MSHA/IR—1132) Summary of selected injury experience and worktime for the mining industry in the United States, 1931-77.** (Mine Safety and Health Administration, Denver, CO (USA). Health and Safety Analysis Center). 1984. 76p. NTIS, PC A05/MF A01. File Number DE86901497.

This report summarizes the principal injury experience and worktime measures of workers at US mining and milling operations for the period 1931-77. These operations are divided into five categories: coal, metallic minerals, nonmetallic minerals (except stone and coal), stone, and sand and gravel. During that period, the injury-experience indices were based on one million man-hours of exposure.

38977 **(MSHA/IR—1144) Injury experience in metallic mineral mining, 1982.** (Mine Safety and Health Administration, Denver, CO (USA). Health and Safety Analysis Center). 1984. 218p. NTIS, PC A10/MF A01. File Number DE86901512.

This report reviews in detail the occupational injury and illness experience of metallic mineral mining in the United States for 1982. Data reported by operators of mining establishments concerning work injuries are summarized by work location, accident classification, part of body injured, nature of injury, occupation, and principal kind of mineral. Related information on employment, worktime, and operating activity also is presented. For ease of comparison with other metal and nonmetallic mineral mining industries and with coal mining, summary reference tabulations are included at the end of the report.

38978 **(MSHA/IR—1145) Injury experience in nonmetallic mineral mining (except stone and coal), 1982.** (Mine Safety and Health Administration, Denver, CO (USA). Health and Safety Analysis Center). 1984. 262p. NTIS, PC A12/MF A01. File Number DE86901511.

This report reviews in detail the occupational injury and illness experience of nonmetallic mineral mining (except stone and coal) in the United States for 1982. Data reported by operators of mining establishments concerning work injuries are summarized by work location, accident classification, part of body injured, nature of injury, occupation, and principal kind of mineral. Related information on employment, worktime, and operating activity also is presented. For ease of comparison with other metal and nonmetallic mineral industries and with coal mining, summary reference tabulations are included at the end of the report.

38979 **(MSHA/IR—1146) Injury experience in stone mining, 1982.** (Mine Safety and Health Administration, Denver, CO (USA). Health and Safety Analysis Center). 1984. 347p. NTIS, PC A15/MF A01. File Number DE86901513.

This report reviews in detail the occupational injury and illness experience of stone mining in the United States for 1982. Data reported by operators of mining establishments concerning work injuries are summarized by work location, accident classification, part of body injured, nature of injury, occupation, and principal kind of stone. Related information on employment, worktime, and operating activity also is presented. For ease of comparison with other metal and nonmetallic mineral mining industries and with coal mining, summary reference tabulations are included at the end of the report.

38980 **(MSHA/IR—1147) Injury experience in sand and gravel mining, 1982.** (Mine Safety and Health Administration, Denver, CO (USA). Health and Safety Analysis Center). 1984. 72p. NTIS, PC A04/MF A01. File Number DE86901493.

This report reviews in detail the occupational injury and illness experience of sand and gravel mining in the United States for 1982. Data reported by operators of mining establishments concerning work injuries are summarized by work location, accident classification, part of body injured, nature of injury, and occupation. Related information on employment, worktime, and operating activity also is presented. For ease of comparison with coal mining and other metal and nonmetallic mineral mining industries, summary reference tabulations are included at the end of the report.

38981 **(MSHA/IR—1173) Injury experience in stone mining, 1983.** (Mine Safety and Health Administration, Denver, CO (USA). Safety and Health Technology Center). 1985. 434p. NTIS, PC A19/MF A01. File Number DE86901502.

This report reviews in detail the occupational injury and illness experience of stone mining in the United States for 1983. Data reported by operators of mining establishments concerning work injuries are summarized by work location, accident classification, part of body injured, nature of injury, occupation, and principal type of mineral. Related information on employment, worktime, and operating activity also is presented. Data reported by independent contractors performing certain work at mining locations are depicted separately in this report. For ease of comparison with other metal and nonmetallic mineral mining industries and with coal mining, summary reference tabulations are included at the end of both the operator and the contractor sections of this report.

38982 (DOE/SSDC—76-45/27-2nd-Ed.) Accident/incident investigation manual. Second edition. (EG and G Idaho, Inc., Idaho Falls (USA)). Nov 1985. Contract AC07-76ID01570. 190p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE86011838.

A fundamental element in a comprehensive, modern safety program is the thorough investigation of accidents and incidents. This manual provides usable guidelines for investigation of all accidents or incidents, and guidance for preparing for accident management and investigation, appointing investigators and investigative boards, reviewing their activities and reports, and taking action on their findings and recommendations. (ACR)

58 GEOSCIENCES

38983 (DOE/ER—0277) Geosciences projects FY 1985 listing. (USDOE Office of Energy Research, Washington, DC. Office of Program Analysis). May 1986. 179p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE86012461.

This report, which updates the previous working group publication issued in February 1982, contains independent sections: (A) Summary Outline of DOE Geoscience and Related Studies, and (B) Crosscut of DOE Geoscience and Geoscience Related Studies. The FY 1985 funding levels for geoscience and related activities in each of the 11 programs within DOE are presented. The 11 programs fall under six DOE organizations: Energy Research Conservation and Renewable Energy; Fossil Energy; Defense Programs; Environmental, Safety, and Health; and Civilian radioactive Waste. From time to time, there is particular need for special interprogrammatic coordination within certain topical areas. section B of the report is intended to fill this need for a topical categorization of the Department's geoscience and related activities. These topical areas in Solid Earth Geosciences, Atmospheric Geosciences, Ocean Geosciences, Space and Solar/Terrestrial Geosciences, and Hydrological Geosciences are presented in this report.

5801 Geology And Hydrology

REFER ALSO TO CITATION(S) 37403, 37631, 37632, 37633, 37634, 37645, 37659, 38913, 38914

38984 (DOE/ER/60152—1) Hydrogeology of rocks of low permeability. Memoires, Volume XVII, Part 1 proceedings. (International Association of Hydrogeologists). 1985. Contract FG02-83ER60152. 442p. (CONF-850101—Pt.1). NTIS, PC A19/MF A01 - GPO. File Number TI86011466.

From International congress on hydrology of rocks of low permeability; Tucson, AZ, USA (7 Jan 1985).

This volume contains papers on numerical and analytical models of mass transport, regional studies, and studies of flow in fractured rocks. Separate abstracts have been prepared for individual papers. (ACR)

38985 (NP—6901446) Alabama Tin Belt. Metallogenesis and mineral resource evaluation. Final report for the 1983-1984 project year. Green, N.L.; Tompa, B.; Gomolka, J.; Wade, G.; Usdansky, S.I. (Alabama Univ., University (USA). Dept. of Geology; Murray State Univ., KY (USA)). Mar 1986. 96p. School of Mines and Energy Development, Univ. of Alabama, Box 6282, University (Tuscaloosa), AL 35486. File Number TI86901446.

The Alabama Tin Belt covers an area of approximately 180 km² within the Tallapoosa lithotectonic block of the Northern Alabama Piedmont. In the second year of this three year project, efforts continued towards detailing the distribution and petrogenesis of tin-bearing peraluminous granitoids in central Coosa County. In particular, mapping, structural analysis and petrographical/petrological studies have been used to examine the geologic settings, geochemical and mineralogical variations, crystallization conditions and nature of source rock(s) of selected granitic plutons and related pegmatite bodies in the vicinity of Rockford, Alabama. Thermobarometeric techniques (a ternary feldspar thermobarometer and a plagioclase-muscovite geothermometer), that could be used in conjunction with compositions of constituent minerals to yield reasonable estmates of granite crystallization and alteration temperatures, were also developed. Preliminary results provide evidence that: (1) the granitoids possess characteristics possibly derived from both sedimentary (S-type) and igneous (I-type) sources; (2) feldspars of the tin-bearing pegmatites possess extremely high Rb and Cs concentrations; (3) the peraluminous granitoids crystallized under varying oxygen fugacity conditions at temperatures of 510 to 710° and pressures greater than 6 kbar; and, (4) the Rockford Pluton occupies the core of a post-D_1, antiformal structure that is overturned to the northwest.

5802 Geophysics

REFER ALSO TO CITATION(S) 37396, 37404, 37487, 38784

38986 (CEA-CONF—8169) Test of SEISPACE seismological DCPs in Ubaye (French Alps). Poupinet, G.; Bresson, A.; Goula, X.; Coutant, O. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete). May 1985. 12p. (CONF-8505286—1; DAS—171). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752447.

From 10. ARGUS conference; Kiel, F.R. Germany (22 May 1985).

A seismological equipment transmitting selected parts of seismograms through ARGOS or METEOSAT has been built. The purpose is to deploy seismological networks for several months in remote and difficult access areas. In seismotectonic and teleseismic studies or for the evaluation of seismic risks, seismicity has to be monitored for long periods of time. This is usually costly in maintenance and data processing. We present an instrument designed to simplify seismological data collection and processing for customary applications. In designing this instrument we rely on the experience acquired in the use of ARGOS for the location of earthquakes on Etna with an analog picker (Poupinet and Glot, 1982, 1983). A test of two DCP installed in a mountainous region during the winter 1984-1985 is presented.

38987 (LA—10706-MS) Detection and evaluation of structural rock damage in the overburden at an underground base. Acoustic transmission method. Bradley, C.R. (Los Alamos National Lab., NM (USA)). Apr 1986. Contract W-7405-ENG-36. 38p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86011742.

A system is proposed to assess blast damage to the rock overlying an underground base. The system consists of vertical wellbores that contain acoustic transceivers and that penetrate potential locations for completion of egress tunnel construction. In this system compressional and shear wave signals are transmitted through the rock between wellbores, and the travel time of the signals is measured. From these measurements, a two-dimensional representation of selected rock properties can be obtained through direct inversion or algebraic tomographic methods. In this report we describe a simplified inversion theory as it relates to transmission acoustics and present two methods for inverting the travel-time data: (1) direct inversion and (2) algebraic reconstruction. We applied the Algebraic Reconstruction Technique (ART) and the Simultaneous Iterative Reconstruction Technique (SIRT), both methods of algebraic reconstruction, to the damage assessment model. The SIRT algorithm was more stable in the presence of measurement uncertainties.

38988 (N—86-20997) Geomagnetic main field modeling using magnetohydrodynamic constraints. Estes, R.H. (Business and Technological Systems, Inc., Seabrook, MD (USA)). Nov 1985. 33p. (NASA-CR—177849; REPT—1080). NTIS, PC A03/MF A01.

The influence of physical constraints which may be approximately satisfied by the Earth's liquid core, are investigated. A previous report describes the methodology used to incorporate nonlinear equations of constraint into the main field model. The application of that methodology to the GSFC 12/83 field model to test the frozen-flux hypothesis and the usefulness of incorporating magnetohydrodynamic constraints for obtaining improved geomagnetic field models are described.

38989 (NUREG/CR—3150) Seismicity and tectonic relationships for Upper Great Lakes Precambrian Shield Province. Final report, July 1981-December 1982. Mooney, H.; Walton, M. (Minnesota Univ., Minneapolis (USA)). Jun 1986. 53p. NTIS, PC A04/MF A01 - GPO. File Number TI86901522.

The Central Minnesota Seismic Array operated from 1 January 1977 to 14 July 1982. The intent of the investigation was to provide a seismicity data base for the Upper Great Lakes Precambrian Shield Province. The results of the investigation are presented as a table listing parameters for 16 earthquakes. The epicenter locations are shown on a tectonic map.

38990 (NUREG/CR—4609) Effects of earthquakes on underground facilities. Literature review and discussion. Carpenter, D.W.; Chung, D.H. (Lawrence Livermore National Lab., CA (USA)). Jun 1986. Contract W-7405-ENG-48. 61p. (UCID—20505). NTIS, PC A04/MF A01 - GPO. File Number TI86012649.

A review of literature concerning effects of ground motion on underground facilities has been completed, and an annotated bibliography has been prepared. This information provides useful background for the science and engineering of underground nuclear waste management facility development. While some conflicts are evident in the literature reviewed, the following tentative conclusions may be drawn from the available information: (1) damage is expectable if fault displacement occurs through a site, but damage from shaking alone is generally confined to facilities located within the epicentral region and may be less than to surface facilities at the same site. (2) Seismic data are mixed, but favors reduction of amplitude with depth; observations appear quite dependent upon station characteristics. (3) The frequency content of earthquake mitions is important to the stability of underground openings and the applicability of attenuation relationships developed in areas where geologic and tectonic characteristics favor high attenuation rates to mid-continental sites is questionable. (4) Model studies indicate problems for shafts and the potential for problems with waste-handling equipment in shafts. The results of the review indicate the need to assure that site-specific response spectra and attenuation relationships are developed for proposed sites, and that detailed assessments of seismic aspects of shaft designs, hoists and in-shaft waste-handling equipment are required.

38991 (NUREG/CR—4632) New Madrid Seismotectonic Program. Final report. Buschbach, T.C. (Saint Louis Univ., MO (USA)). Jun 1986. 73p. NTIS, PC A04/MF A01 - GPO. File Number TI86901521.

The New Madrid Seismotectonic Program was a large-scale multidisciplinary effort that was designed to define the structural setting and tectonic history of the New Madrid area in order to realistically evaluate earthquake risks in the siting of nuclear facilities. The tectonic model proposed to explain the New Madrid seismicity is the "zone of weakness" model, which suggests that an ancient rift complex formed a zone of weakness in the earth's crust along which regional stresses are relieved. The Reelfoot Rift portion of the proposed rift complex is currently seismically active, and it must be considered capable and likely to be exposed to large-magnitude earthquakes in the future. Earthquakes that occur in the Wabash Valley area are less abundant and generally have deeper hypocenters than earthquakes in the New Madrid area. The area of the Southern Indiana Arm must be considered to have seismic risk, although a lesser extent than the Reelfoot Rift. The east-west trending Rough Creek Graben is practically aseismic, probably in large part due to its orientation in the current stress field. The northwest-trending St. Louis Arm of the proposed rift complex includes a pattern of seismicity that extends from southern Illinois along the Mississippi River. This arm must be considered to have seismic risk, but because of the lack of development of a graben associated with the arm and the orientation of the arm in the current stress field, the risk appears to be less than in the Reelfoot Rift portion of the rift complex.

38992 (PB—86-189453/XAB) Investigation of radon and helium as possible fluid-phase precursors to earthquakes. Technical report. Chung, Y.; Craig, H. (Scripps Institution of Oceanography, La Jolla, CA (USA)). Apr 1986. 54p. (SIO-REF—86-12). NTIS, PC A04/MF A01.

The final technical report represents the radon data obtained from three sites with USC Continuous Radon Monitors (CRM's), and the new discrete data on radon and helium in the liquid phase from the current S. California network sites for the period October, 1984 to November, 1985. The monitoring network of hot springs and thermal wells was established along the Elsinore, San Jacinto, and San Andreas faults between San Bernardino and the Mexican border since 1974. Water samples from the network sites were measured at monthly intervals during the report period.

38993 (SAND—86-0629) Geoscience Research Drilling Office Operations I: the North INYO Drilling Program, 1984. Lysne, P. (Sandia National Labs., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012041.

The North Inyo Drilling Program was part of the Continental Scientific Drilling Program/Thermal Regimes and it was put forth by the Department of Energy/Office of Basic Energy Sciences to explore roots of a 600 year old volcanic system which is found in the north-west corner of Long Valley Caldera, California. The responsibility of the Geoscience Research Drilling Office was to provide logistical support to the scientific drilling team. This support consisted of obtaining the necessary permits, obtaining a drilling contract and providing field services involving logging and core handling/laboratory facilities. The first portion of this program was successful when hole RDO-2b traversed the conduit which fed Obsidian Dome; the second portion succeeded when RDO-3a traversed the dike underlying the Inyo Chain of volcanoes.

38994 (SAND—86-0938C) First 1.5 years with the Norwegian Regional Seismic Array, October 1984-March 1986. Breding, D.R. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 25p. (CONF-8604196—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010097.

From RSTN/NORESS research symposium; Las Vegas, NV, USA (30 Apr 1986).

This presentation details Sandia National Laboratories' operational experience with the Norwegian Regional Seismic Array (NRSA) over its first 1.5 years. It outlines the events that are important to those that use the NRSA data. These events include when and where data was recorded and array changes that affect the user. In addition, statistics on data outages ad data availability will be presented.

38995 Recent experiments using geophysical tomography in fractured granite. Ramirez, A.L. (Lawrence Livermore Lab., Livermore). *Proceedings of the IEEE (Institute of Electrical and Electronics Engineers);* 74: No. 2, vp(Feb 1986). Contract W-7405-ENG-48.

This paper provides overviews of recent field experiments where the geophysical tomography method was used to investigate fractures between boreholes and an overview of factors pertinent to accuracy, resolution, and data interpretation. High-frequency electromagnetic waves (5-40 MHz) were used in the field to investigate a fractured granitic rock mass between boreholes separated by up to 30 m. Geophysical tomography images were reconstructed and compared with borehole geophysical data and hydraulic conductivity data. These comparisons suggest that the images are useful in identifying regions in the granite having a high moisture content due to fracture zones. A new technique involving the use of salt-water tracers to delineate fluid flow through fractures has been preliminarily evaluated. Image anomalies created by the tracer can be correlated with fracture data. This technique requires further evaluation because available fracture data are insufficient to delineate flow paths independently. When fractures are sampled from two boreholes, the resolution of the method is a function of the height-to-width ratio of the area investigated, the fracture location within this area, and the orientation of the fractures. The ratio of displacement to conduction currents, the variability of the refractive index in the rock, and the separation between transmitter and receiver are also important parameters affecting imaging results.

38996 **Effects of contact area of an interface on acoustic wave transmission characteristics.** Myer, L.R.; Hopkins, D.; Cook, N.G.W. (Lawrence Berkeley Lab., CA). pp 565-572 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—). Contract AC03-76SF00098.

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

Attenuation and dispersions of waves are attributed to energy losses caused by mechanisms such as frictional sliding between areas of contact in fractures, and viscosity and flow of fluid in pores and fractures (Johnston et al. 1979, White 1983). Energy loss by these mechanisms has been accounted for in theoretical models by defining a complex material modulus (O'Connell and Budiansky 1977, Kjartansson 1979). Models predicting apparent attenuation due to scattering of seismic waves by cracks or fractures have been proposed by Yamakawa (1962) and Hudson (1981). This paper discusses a new model in which attenuation as well as group velocity changes are explained by a single set of assumptions. The basis of this model is that a joint or fracture represents a displacement discontinuity across which average stresses in seismic waves are continuous but displacements are not. The model is linear elastic so that all material properties are real valued. It is applicable to cases in which the fractures are large in extent but small in thickness compared to the wavelength of the seismic waves. Laboratory experiments were performed in which a single fracture was represented by an interface between two steel cylinders. Measured attenuation of compressional (P) and polarized shear (S) waves was compared with model predictions.

38997 **Electrode configuration influence on resistivity measurements about a spherical anomaly.** Lytle, R.J.; Hanson, J.M. (Lawrence Livermore National Lab., CA). *Geophysics;* 48: No. 8, 1113-1119(Aug 1983). Contract W-7405-ENG-48.

The trade-offs involved with subsurface resistivity probing are studied for the case of a spherical anomaly. In particular, two-, three-, and four-electrode configurations are investigated. The three- and four-electrode configurations have similar results and have significantly better remote detection capabilities than does a two-electrode configuration. Cross-borehole probing is capable of detecting anomalous conditions at a greater range than is single-borehole probing.

5803 Mineralogy, Petrology, And Rock Mechanics

REFER ALSO TO CITATION(S) 37628, 38413, 38996, 39283

38998 **(BMI/ONWI—573(1)) Full-scale borehole sealing test in salt under simulated downhole conditions. Volume 1.** Bush, D.D.; Piele, S. (Terra Tek, Inc., Salt Lake City, UT (USA)). May 1986. Contract AC02-83CH10140. 149p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86012040.

A full-scale borehole sealing test was conducted in Avery Island diapiric salt. The test was performed under simulated in situ stress (15.86 MPa [2300 psi]) and temperature (30°C) of a theoretical salt nuclear waste repository. To evaluate the sealing performance and the effect of the grout on the salt, temperature and pressure versus time histories of the grout were measured during the 28-day curing period and subsequent full-scale flow tests. Post-test microscopic tests, physical properties tests, and laboratory permeability tests were conducted on the grout and host rock. Data indicate the grout exothermic reaction was low (<5°C) with the expansive stresses in the grout exceeding 11.0 MPa (1595 psi) near the center and 24.8 MPa (3600 psi) at the grout/salt interface. The full-scale flow test conducted over 91 hours resulted in a non-steady-state flow, decreasing with time to approximately 10^{-6} darcys. Megascopic and microscopic examinations revealed fluid flow along a small area of the grout/salt interface and through adjacent salt. Laboratory data show a salt permeability in the order of 10^{-5} and grout at 10^{-6} darcys. Physical and permeability data indicate the salt has anisotropic properties.

38999 **(BMI/ONWI—573(2)) Full-scale borehole sealing test in salt under simulated downhole conditions. Volume 2.** Scheetz, B.E.; Licastro, P.H.; Roy, D.M. (Pennsylvania State Univ., University Park (USA). Materials Research Lab.). May 1986. Contract AC02-83CH10140. 79p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012003.

Large-scale testing of the permeability by brine of a salt/grout sample designed to simulate a borehole plug was conducted. The results of these tests showed that a quantity of fluid equivalent to a permeability of 3 microdarcys was collected during the course of the test. This flow rate was used to estimate the smooth bore aperture. Details of this test ware presented in Volume 1 of this report. This report, Volume 2, covers post-test characterization including a detailed study of the salt/grout interface, as well as determination of the physical/mechanical properties of grout samples molded at Terra Tek, Inc. at the time of the large-scale test. Additional studies include heat of hydration, radial stress, and longitudinal volume changes for an equivalent grout mixture.

39000 **(BMI/ONWI—581(1)) Full-scale borehole sealing test in anhydrite under simulated downhole conditions. Volume 1.** Bush, D.D.; Lingle, R. (Terra Tek, Inc., Salt Lake City, UT (USA)). May 1986. Contract AC02-83CH10140. 82p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012073.

A full-scale borehole sealing test was conducted in anhydrite. The test was performed under the simulated in situ stress (4.83 MPa [700 psi] and temperature (30°C) of a theoretical deposit overlying a nuclear waste repository. The borehole sealing material was an expansive grout formulated by the US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, under contract to the US Department of Energy. To evaluate and better understand the expansive nature of the grout, in situ pressure and temperature versus time histories were measured during the 29-day curing period and subsequent full-scale flow tests. Post-test microscopic and laboratory permeability tests were conducted on the grout and anhydrite. Data indicate the grout exothermic reaction was low (6°C), with the expansive stresses approaching 2.55 MPa (370 psi) near the center, and 3.8 MPa (551 psi) at the interface, prior to transducer failure on day 17. The full-scale flow test conducted at the conclusion of the 29-day curing period resulted in large-scale flow. Megascopic post-test examination of the grout revealed channeling and apparent dissolution at the grout-anhydrite interface. Microscopic examination revealed voids within the grout, with laboratory tests showing a permeability of 10^{-6} darcys. Numerous fractures were evident in the anhydrite.

39001 **(BMI/ONWI—581(2)) Full-scale borehole sealing test in anhydrite under simulated downhole conditions. Volume 2.** Scheetz, B.E.; Licastro, P.H.; Roy, D.M. (Pennsylvania State Univ., University Park (USA). Materials Research Lab.). May 1986. Contract AC02-83CH10140. 63p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86012074.

The large bench-scale permeability testing of anhydrite rock and a grout designed to act as a seal in contact with this rock was conducted at the Terra Tek, Inc. research facility in Salt Lake City, Utah. Pressurized flow of a dye-marked fluid from the borehole cavity of the test specimen was recorded at 45 psi (0.31 MPa) differential head pressure. Test parameters were altered and the flow recorded for differential pressures varying up to about 125 psi (0.86 MPa) in 25 psi (0.17 MPa) intervals with a constant confining pressure. In all cases, the fluid flow was observed to increase. The dimensions of the test specimen and test conditions correspond to an observed permeability of between 0.84 and 1.5 millidarcys, based upon the grout plug area. Post-test examination of the rock/grout core indicated that the flow was principally interfacial flow. However, marked flow paths within the grout were also noted. The development of numerous heavily dye-marked "washout" regions in the grout at the interface suggests that these channels acted as the main conduits for fluid flow from the borehole. A tentative explanation for the development of the large conduits was the formation of bubble trains in the paste. Similar behavior was observed in a laboratory-scale grout formulation at the Pennsylvania State University that approximated the rheologic properties and composition

of the tested grout, TT84A. The performance of the melamine-based superplasticizer used in the formulation is questioned regarding its sealing ability in anhydrite.

39002 **(BMI/ONWI—598) Salt dissolution and collapse at the Wink Sink in West Texas.** Johnson, K.S. (Battelle Memorial Inst., Columbus, OH (USA). Office of Nuclear Waste Isolation). Jun 1986. Contract AC02-83CH10140. 96p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86012245.

The Wink Sink, in Winkler County, Texas, is a collapse feature that formed in June 1980 when an underground dissolution cavity migrated upward by successive roof failures until it breached the land surface. The original cavity developed in the Permian Salado Formation salt beds more than 1300 feet below ground level. Natural dissolution of salt occurred in the vicinity of the Wink Sink in several episodes that began as early as Salado time and recurred in later Permian, Triassic, and Cenozoic time. Although natural dissolution cavity and resultant collapse were influenced by petroleum production activity in the immediate area. Drilling, completion, and plugging procedures used on an abandoned oil well at the site of the sink appear to have created a conduit that enabled water to circulate down the borehole and dissolve the salt. When the dissolution cavity became large enough, the roof failed and the overlying rocks collapsed into the cavity. Similar collapse features exist where underground salt beds have been intentionally dissolved during solution mining or accidentally dissolved as a result of petroleum production activities.

39003 **(NP—6770110) Establishment of core laboratory competence. Triaxial tests at reservoir pressure. Relative permeability. Standard core laboratory tests.** (Geoteknisk Inst., Lyngby (Denmark); Danmarks Geologiske Undersoegelske, Copenhagen). Sep 1985. 190p. (In Danish). NTIS (US Sales Only), PC A09/MF A01. File Number DE86770110.

Items within the scope of EDB have been entered individually into the data base. (ACR)

39004 **(NUREG/CR—4641) Experimental assessment of borehole wall drilling damage in basaltic rocks.** Fuenkajorn, K.; Daemen, J.J.K. (Arizona Univ., Tucson (USA). Dept. of Mining and Geological Engineering). Jun 1986. 287p. NTIS, PC A13/MF A01 - GPO. File Number TI86901531.

Ring tension tests, permeability tests, and microscopic fracture studies have been performed to investigate the borehole damage induced at low confining pressure by three drilling techniques (diamond, percussion and rotary). Specimens are drilled with three hole sizes (38, 76, and 102 mm diameter) in Pomona basalt and Grande basaltic andesite. The damaged zone is characterized in terms of fractures and fracture patterns around the hole, and in terms of tensile strength reduction of the rock around the holes. Experimental results show that the thickness of the damaged zone around the hole ranges from 0.0 to 1.7 mm. A larger drill bit induces more wall damage than does a smaller one. Different drilling techniques show different damage characteristics (intensity and distribution). Damage characteristics are governed not only by drilling parameters (bit size, weight on bit, rotational speed, diamond radius, and energy), but also by properties of the rock. The weaker rock tends to show more intense damage than does the stronger one. Cracks within grains or cleavage fractures are predominant in slightly coarser grained rock (larger than 0.5 mm grain size) while intergranular cracks are predominant in very fine grained rock (smaller than 0.01 mm grain size). The damaged zones play no significant role in the flow path around a borehole plug.

39005 **(PNL-SA—13816) Coupled mechanical-hydrological methodology for modeling flow in jointed rock masses using laboratory data for the joint flow model.** Voss, C.F.; Bastian, R.J.; Shotwell, L.R. (Pacific Northwest Labs., Richland, WA (USA)). Feb 1986. Contract AC06-76RL01830. 5p. (CONF-860609—16). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012332.

From 27. U.S. symposium on rock mechanics; Tuscaloosa, AL, USA (23 Jun 1986).

Pacific Northwest Laboratory (PNL) currently supports the US Department of Energy's Office of Civilian Radioactive Waste Management in developing and evaluating analytical methods for assessing the suitability of sites for geologic disposal of high-level radioactive waste. The research includes consideration of hydrological, geomechanical, geochemical, and waste package components and the evaluation of the degree of coupling that can occur between two or more of these components. The PNL effort and those of other research groups investing potential waste sites in the US and abroad are producing a suite of computer codes to analyze the long-term performance of the proposed repository sites. This paper summarizes the ongoing research in rock mechanics at PNL involving flow through jointed rock. The objective of this research is to develop a methodology for modeling the coupled mechanical-hydrological process of flow through joints and then attempt to validate a "simple" model using small-scale laboratory test data as a basis for judging whether the approach has merit. This paper discusses the laboratory tests being conducted to develop a joint behavioral constitutive model for the numerical method under development and the modeling approach being considered.

39006 **(SAND—84-2620) G-tunnel heated block experiment. Final report.** Zimmerman, R.M.; Schuch, R.L.; Mason, D.S.; Wilson, M.L.; Hall, M.E.; Board, M.P.; Bellman, R.P.; Blanford, M.P. (Sandia National Labs., Albuquerque, NM (USA); EG and G, Inc., Las Vegas, NV (USA); Science Applications International Corp., Las Vegas, NV (USA); RE/SPEC, Inc., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 412p. NTIS, PC A18/MF A01; 1; GPO Dep. File Number DE86011768.

A heated block experiment was conducted in G-Tunnel on the Nevada Test Site (NTS) to provide input for evaluating the ability of jointed-welded tuffs to contain radioactive wastes. The Nevada Nuclear Waste Storage Investigations Project is investigating the possibility of constructing a high-level nuclear waste repository within similar tuff at Yucca Mountain on and adjacent to the NTS. The heated block experiment included tests to evaluate the behavior of tuff under higher than ambient stresses and temperatures. Field data were collected on thermal, mechanical, thermomechanical, and hydrologic properties of tuff. The experiment, together with laboratory tests on tuff, provides information that increases the levels of confidence and accuracy when extrapolations are made to a full-scale repository.

39007 **(SAND—86-1034C) Stress measurements in rock salt using hydraulic fracturing.** Wawersik, W.R.; Stone, C.M. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 13p. (CONF-8604199—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010096.

From Spring meeting on hydrofracture tests of US salt; Baton Rouge, LA, USA (20 Apr 1986).

Hydraulic fracturing was applied in horizontal drillholes in the Salado salt formation near Carlsbad, New Mexico. Testing took place approximately 650 m below surface in order to support the design of a Waste Isolation Pilot Plant (WIPP) for the disposal of radioactive waste from defense activities of the United States. Hydraulic fracturing was performed primarily to determine whether the virgin in situ stress state at the WIPP site is isotropic and whether the magnitudes of the the virgin in situ stresses correspond to the weight of the overburden. Beyond these limited objectives, measurements are being analyzed to evaluate the usefulness of hydraulic fracturing in salt formations in general. Such measurements are desirable to determine stresses induced by mining and to monitor time-dependent stress changes around underground excavations in salt masses. Hydraulic fracturing measurements are also relevant to the evaluation of allowable pressures before fracturing is induced in pressurized boreholes and storage caverns.

39008 **(UCRL—53721) Variation in properties of nuclear test areas and media at the Nevada Test Site.** Howard, N.W. (Lawrence Livermore National Lab., CA (USA)). 15 Sep 1985. Contract W-7405-ENG-48. 49p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012104.

Data have gradually been accumulating on the physical properties of nuclear test sites at the US Department of Energy's (DOE) Nevada Test Site (NTS) since underground testing began

there in 1957. These data have been stored in the Lawrence Livermore National Laboratory (LLNL) Containment Program's Test Effects and Geologic Data Bank. This report briefly describes the principal test areas (Yucca Flat, Frenchman Flat, Pahute Mesa, Climax Stock, and Rainier Mesa) and media (alluvium, tuff, rhyolite lavas, granite, and carbonate rocks) at the NTS. The data base and the various methods used to measure geophysical parameters at the NTS are described. The mean, standard deviation, and range of values for each test area and medium are given. However, this report does not contain specific properties for individual sites. Properties for which averages are listed include bulk density, seismic velocity, and gas-filled porosity, both near the working point (WP) and from the WP to the surface; and grain density, water content, porosity, water saturation, and CO_2 content of the rocks in the WP vicinity.

39009 **The kinematics of block interpenetrations.** Shi, G.; Goodman, R.E.; Tinucci, J.P. (Univ. of California, Berkeley; Lawrence Berkeley Labs., CA). pp 121-130 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—).

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

In 1968 joint elements were introduced in finite element analyses (1) to represent the contribution of discontinuities in the mechanical behavior of rock systems. After some initial studies it became obvious that a series of constraints would have to be introduced on the deformations and stresses in the joint elements to prevent one block from interpenetrating another, to avoid the accumulation of tensile stresses between blocks, and to limit the shear stresses along joints to tolerable values. These additions permitted sophisticated computations of stresses and strains in jointed rocks, with some numerical difficulties, and in well-posed problems valuable results have been obtained. Subsequently, workers in other fields applied similar algorithms to computation of interfaces between dissimilar materials in both static and dynamic problems. Interface constraints have been used by workers employing finite difference, discrete element, and finite element methods. Recently the authors introduced a method called "discontinuous deformation analysis" (2) for backcalculation of deformational modes in blocky rock systems when one is given the displacements of a sufficient set of points. The examples of that paper employed a more thorough approach for meeting the constraints required for nonpenetration of blocks; and the success achieved using this method in complexly jointed systems led us to generalize the equations and procedures so that they might be introduced in finite element, finite difference, and discrete element computations as well. This paper is written to present these general formulations.

39010 **Calculation of laboratory stress-strain behavior using a compliant joint model.** Labreche, D.A. (RE/SPEC Inc., Albuquerque, NM). pp 515-522 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—).

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

Numerous models of the discontinuities within a rock mass have been developed in attempts to simulate their mechanical effects. These models fall into two categories: discontinuous models and continuum models, each with its advantages and disadvantages under particular applications. The discontinuous models are those that explicitly model individual discontinuities (faults, joints, etc.), e.g., Goodman, et al [1968], and Ghaboussi, et al [1973]. Continuum models are those which simulate some effects of discontinuities within a portion or all of the problem domain without modeling the discontinuity itself. A continuum-type compliant joint model was developed so that joints can be spread throughout the volume of interest, and aperture changes can be monitored. Validation ensures that the mathematical field theory embodied in a computer code is a correct representation of the phenomena it simulates. The validation process includes comparing calculations with measurements and observations made during field and laboratory studies. This paper presents a brief description of the compliant joint model, a description of laboratory experiments used for this validation, the numerical idealization of those experiments, and the calculated results that complete this preliminary validation analysis. An evaluation of observed differences is made.

39011 **Measurement and calculation of the mechanical response of a highly fractured rock.** Bauer, S.J.; Thomas, R.K.; Ford, L.M. (US Dept. of Energy Facility, Sandia National Labs., Albuquerque, NM). pp 523-530 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—). Contract AC04-76DP00789.

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

The authors have completed the first steps in attempting to validate a material constitutive model for a jointed rock mass. The continuum model (Thomas, 1981), as utilized here within a finite element code, consists of a material constitutive description based on the linear elastic behavior of the matrix material and nonlinear normal and shear behavior of fracture planes. The validation exercise consists of (1) characterizing an appropriate physical model, (2) measuring the mechanical response of that model, and (3) using the physical model characteristics to calculate the mechanical response of the physical model. Calculated and measured responses for small-scale physical models (thermally-fractured granite [Bauer, 1980]) are in qualitative agreement. For deviatoric loadings, the calculated tangent modulus is an order of magnitude less than that of the matrix and exhibits stiffening with increasing a load, and thereby functionally tracks the measured response.

5804 Geochemistry

REFER ALSO TO CITATION(S) 38878

39012 **(SAND—86-0237C) Micro-Raman spectroscopy of fluid inclusions in a hopper crystal in halite.** Higgins, K.L.; Stein, C.L. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 13p. (CONF-860829—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007628.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Raman microscopy has been used successfully to analyze for dissolved sulfate in fluid inclusions in naturally occurring halite. Hopper crystals are crystals of halite (NaCl) whose structure is produced by crystal growth at the surface of a brine reservoir. Brine is trapped by defects in the growing crystal faces as microscopic fluid inclusions. In this study the hopper crystal was characterized by obtaining a profile of the sulfate (SO_4^{2-}) concentrations in brine inclusions in the bands formed in the hopper crystal structure. In addition, the same sample contained large areas of clear recrystallized halite in which fluid inclusions are not as abundant as those in hopper crystals but are several orders of magnitude larger (frequently several mm on an edge). These larger inclusions were also analyzed for their sulfate content. The sample for this study came from a thick halite unit in the Salado Formation (Permian age) in the Delaware Basin, southeastern New Mexico. The Waste Isolation Pilot Plant (WIPP) is located at a depth of approximately 2150 feet from the surface.

5805 Oceanography

REFER ALSO TO CITATION(S) 37627, 38916, 38917, 38918, 38919

39013 **(SAND—85-7226) Data report on sediment cores collected on cruise W8209-B, Pacific study area W-N.** Heath, G.R.; Lopez, C. (Oregon State Univ., Corvallis (USA). Coll. of Oceanography). May 1986. Contract AC04-76DP00789. 37p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86011823.

Sediment cores from area W-N (centered at 39° 20' N, 127° 35' W) collected during cruise W8209B, in September 1982, supplement the coverage obtained during the earlier Low-Level Waste Ocean Disposal Program cruises TT-141 (OSU-8) and W8103A (OSU-18). As before, the cores in W-N are cohesive clays, silty

clays and clayey silts. The brown (surficial) to gray green (deeper) color change, indicative of Fe^{+3} to Fe^{+2} reduction by organic matter, increases in depth from less than 10 cm in the eastern half of the area to more than 40 cm to the west. In a core collected about 50 km west of W-N, the boundary lies below 2 m, indicating the increasingly oxidized condition of the sediment towards the central North Pacific gyre due to reduced organic influx and a slower sedimentation rate.

39014 (SAND—85-7232) Acoustic structure and echo character of surficial sediments of the northern Hatteras Abyssal Plain. McCreery, C.J.; Laine, E.P. (Rhode Island Univ., Narragansett (USA)). May 1986. Contract AC04-76DP00789. 120p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86011959.

A study has been made of the high frequency acoustic response of abyssal plain depositional facies. Piston cores have been obtained at six stations and deep hydrophone recordings at three stations on the northern Hatteras Abyssal Plain. 3.5 kHz seismic profiles indicate acoustically transparent lobes of surficial sediment which thicken towards the Hatteral Transverse Canyon and Sohm Gap/Wilmington Fan. Physical property data from piston cores indicate a higher percentage of coarse sediment in the areas of transparent acoustic response. Many of the characteristics normally used in mapping of conventional 3.5 kHz profiler acoustic response varied only slightly in the study area. Regions of diffuse 3.5 kHz surface echoes, similar to prolonged echoes attributed to high percent sand beds, have been identified in the study area. High trace to trace variation in deep hydrophone/pinger recordings in these areas suggests that the diffuse echo returns are due to unresolved microtopography and are not necessarily associated with a sandy seafloor.

39015 (SAND—85-7233) Late Quarternary evolution of the northern Hatteras Abyssal Plain. Dickson, S.M.; Laine, E.P. (Rhode Island Univ., Narragansett (USA)). May 1986. Contract AC04-76DP00789. 180p. NTIS, PC A09/MF A01; GPO Dep. File Number DE86011961.

The sedimentary history and seismic structure of a deep-water turbidite basin in the Western North Atlantic Ocean has been investigated to understand further the evolution of abyssal plains. This study integrates analyses of sedimentary and seismic facies in order to examine the temporal and spatial patterns of sedimentation on the northern Hatteras Abyssal Plain during the Late Quaternary. Forty deep-sea sediment cores and 6000 km of high resolution (3.5 kHz) seismic reflection profiles from within 31-34°N and 69-74°W include portions of the Hatteras Outer Ridge, Lower Continental Rise and Bermuda Rise as well as the northern Hatteras Abyssal Plain. Seismic profiles (within 32-33°N, 70-71.5°W) define two acoustically-transparent seismic units beneath the Plain. The composition of these seismic units has been investigated with sediment cores. This study has found two notable features in the sedimentary framework of the Plain that appear to have resulted from temporal changes in sediment supply. The most recent change, a postglacial decline in turbidity current activity, produced a diagenetic iron enrichment at the Pleistocene-Holocene boundary. The stratigraphic thickness affected by diagenesis is related spatially to patterns of turbidite sedimentation. An earlier change, discovered in this research, occurred during the Wisconsinian glaciation and brought coarser-grained turbidity currents to the northern Plain. Deposition of sands from these flows appears to have been locally controlled by a broad topographic feature with less than ten meters relief. As a result of the topographic influence, there are abrupt boundaries, both verically and laterally, between an older mud facies and a younger sandy turbidite facies of the Plain.

39016 Pycnocline development and its consequences in the Middle Atlantic Bight. Aikman, F. III. (Columbia Univ., New York, NY). *Journal of Geophysical Research;* **89**: No. C1, 685-694(20 Jan 1984).

Seasonal pycnocline development in the shelf and slope waters of the Middle Atlantic Bight is investigated numerically using a one-dimensional, two-layer, bulk-mixing model. The model considers the buoyancy budget of the system and includes both turbulent diffusion and entrainment across the pycnocline that separates the layers as well as as a parameterization for mixed-layed shallowing. Climatic estimates of the surface buoyancy and energy inputs drive the model. The shelf and slope water regimes, however, experience different inputs: freshening, due to river runoff, and a larger net heat gain, due to a more positive air-sea temperature difference, both contribute to a larger buoyancy input to the shelf water regime; and the wind stress is larger over the slope. Numerical computation of vernal pycnocline development results in the formation of a shelf water pycnocline that is both shallower and more intense than that over the slope. A consequence of this mismatch is a reversal of the offshore density gradient at intermediate depths and an intrusion of slope water into the shelf water pycnocline, called the pycnocline salinity maximum. It is possible that interannual variations in the timing and magnitude of the heating and freshwater input from rivers can cause concomitant variations in salt input via the pycnocline salinity maximum. 37 references, 11 figures, 2 tables.

64 PHYSICS I

6401 Astrophysics And Cosmology

REFER ALSO TO CITATION(S) 38503, 39129, 39167, 39169, 39234, 39271

39017 (FNAL/Pub—86/69-A) Yet another possible explanation of the solar-neutrino puzzle. Kolb, E.W.; Turner, M.S.; Walker, T.P. (Fermi National Accelerator Lab., Batavia, IL (USA)). Apr 1986. Contract AC02-76CH03000. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012306.

Mikheyev and Smirnov have shown that the interactions of neutrinos with matter can result in the conversion of electron neutrinos produced in the center of the sun to muon neutrinos. Bethe has exploited this and has pointed out that the solar-neutrino puzzle can be resolved if the mass difference squared of the two neutrinos is $m_2^2 - m_1^2 \simeq 6 \times 10^{-5}$ eV^2, and the mixing angle satisfies sin θ/sub v/ > 0.0065. We discuss a qualitatively different solution to the solar-neutrino puzzle which requires $1.0 \times 10^{-8} < (m_2^2 - m_1^2)$ (sin^2 2θ/sub v//cos 2θ/sub v/) $< 6.1 \times 10^{-8}$ eV^2. Our solutions result in a much smaller flux of neutrinos from the p - p process than predicted by standard solar models, while Bethe's solution results in a flux of neutrinos from the p - process that is about the same as standard solar models.

39018 (FNAL/Pub—86/71-A) General constraints on the age and chemical evolution of the Galaxy. Meyer, B.S.; Schramm, D.N. (Chicago Univ., IL (USA); Fermi National Accelerator Lab., Batavia, IL (USA)). May 1986. Contract AC02-76CH03000. 48p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012305.

The formalism of Schramm and Wasserburg (1970) for determining the mean age of the elements is extended. Model-independent constraints (constraints that are independent of a specific form for the effective nucleosynthesis rate and Galactic chemical evolution over time) are derived on the first four terms in the expansion giving the mean age of the elements, and from these constraints limits are derived on the total duration of nucleosynthesis. These limits require only input of the Schramm-Wasserburg parameter Δ/sup max/ and of the ratio of the mean time for formation of the elements to the total duration of nucleosynthesis, t/sub nu//T. The former quantity is a function of nuclear input parameters. Limits on the latter are obtained from constraints on the relative rate of nucleosynthesis derived from the ^{232}Th/^{238}U, ^{235}U/^{238}U, and shorter-lived chronometric pairs. 65 refs.

39019 (FNAL/Pub—86/81-A) Neutrinos from gravitational collapse. Mayle, R.; Wilson, J.R.; Schramm, D.N. (Fermi National Accelerator Lab., Batavia, IL (USA)). May 1986. Contract AC02-76CH03000. 36p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012304.

Detailed calculations are made of the neutrino spectra emitted during gravitational collapse events (Type II supernovae). Those aspects of the neutrino signal which are relatively independent of the collapse model and those aspects which are sensitive to model details are discussed. The easier-to-detect high energy tail of

the emitted neutrinos has been calculated using the Boltzmann equation which is compared with the result of the traditional multigroup flux limited diffusion calculations. 8 figs., 28 refs.

39020 (LBL—21436) Topics in inflationary cosmologies. Mahajan, S. (Lawrence Berkeley Lab., CA (USA)). Apr 1986. Contract AC03-76SF00098. 63p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86012015.

Thesis.

Several aspects of inflationary cosmologies are discussed. An introduction to the standard hot big bang cosmological model is reviewed, and some of the problems associated with it are presented. A short review of the proposals for solving the cosmological conundrums of the big bang model is presented. Old and the new inflationary scenarios are discussed and shown to be unacceptable. Some alternative scenarios especially those using supersymmetry are reviewed briefly. A study is given of inflationary models where the same set of fields that breaks supersymmetry is also responsible for inflation. In these models, the scale of supersymmetry breaking is related to the slope of the potential near the origin and can thus be kept low. It is found that a supersymmetry breaking scale of the order of the weak breaking scale. The cosmology obtained from the simplest of such models is discussed in detail and it is shown that there are no particular problems except a low reheating temperature and a violation of the thermal constraint. A possible solution to the thermal constraint problem is given by introducing a second field, and the role played by this second field in the scenario is discussed. An alternative mechanism for the generation of baryon number within the framework of supergravity inflationary models is studied using the gravitational couplings of the heavy fields with the hidden sector (the sector which breaks supersymmetry). This mechanism is applied to two specific models - one with and one without supersymmetry breaking. The baryon to entropy ratio is found to be dependent on parameters which are model dependent. Finally, the effect of direct coupling between the two sectors on results is related, 88 refs., 6 figs.

39021 (N—86-20995) Calculation of theoretical chromospheric models and the interpretation of solar spectra from rockets and spacecraft. Semiannual Report, 1 January-31 December 1985. Avrett, E.H. (Smithsonian Institution, Cambridge, MA (USA). Smithsonian Astrophysical Observatory). Feb 1986. 68p. (NASA-CR—176573; SAR—20; SAR—21). NTIS, PC A04/MF A01.

Calculated results based on two chromospheric flare models F1 and F2 of Machado, et al., (1980) are presented. Two additional models are included: F1*, which has enhanced temperatures relative to the weak-flare model F1 in the upper photosphere and low chromosphere, and F3 which has enhanced temperatures relative to the strong flare model F2 in the upper chromosphere. Each model is specified by means of a given variation of the temperature as a function of column mass. The corresponding variation of particle density and the geometrical height scale are determined by assuming hydrostatic equilibrium. The coupled equations of statistical equilibrium is solved as is radiative transfer for H, H-, He I-II, C I-IV, Si I-II, Mg I-II, Fe, Al, O I-II, Na, and Ca II. The overall absorption and emission of radiation by lines throughout the spectrum is determined by means of a reduced set of opacities sampled from a compilation of over 10 to the 7th power individual lines. That the white flight flare continuum may arise by extreme chromospheric overheating as well as by an enhancement of the minimum temperature region is also shown. The radiative cooling rate calculations for our brightest flare model suggest that chromospheric overheating provides enhanced radiation that could cause significant heating deep in the flare atmosphere.

39022 (N—86-21475) Hydrogen line ratios in Seyfert galaxies and low redshift quasars. Final Technical Report, 1 June 1983-31 July 1984. Kriss, G.R. (Michigan Univ., Ann Arbor (USA)). 1984. 14p. (NASA-CR—176547). NTIS, PC A02/MF A01.

New observations of the Lymal alpha radiation/hydrogen alpha radiation ratio in a set of x-ray selected active galactic nuclei and an archival study of International Ultraviolet Explorer (IUE) observations of Lymal alpha low redshift quasars and Seyfert galaxies have been used to form a large sample for studying the influence of soft x rays on the enhancement of Balmer emission in the broad line region. In common models of broad line clouds, the Balmer lines are formed deep in the interior, largely by collisional excitation. Heating within the clouds is provided by soft x-ray radiation, while Lymal alpha is formed mainly by recombination after photoionization. The ratio Lymal alpha/H alpha is expected to depend weakly on the ratio of ionizing ultraviolet luminosity to x-ray luminosity (L sub UV/I sub x). If the Lymal alpha luminosity is used as a measure of L sub UV' a weak dependence of Lymal/H alpha on the x-ray luminosity is found similar to previous results.

39023 (N—86-21476) Theoretical studies of chromospheres and winds in cool stars. Semiannual Progress Report, 1 April-30 September 1985. Hartmann, L. (Smithsonian Institution, Cambridge, MA (USA). Smithsonian Astrophysical Observatory). Jan 1986. 18p. (NASA-CR—176524; SAPR—4). NTIS, PC A02/MF A01.

Propagation of pulsational waves through the atmosphere of the M supergiant alpha Ori was explored using a time dependent hydrodynamic code. Wind properties for three FU Orionis objects were determined using radiative transfer models based on optical line profiles. The effects of varying wind temperature while keeping the velocity steady were considered. Using the premise that FU Orionis eruptions result from massive accretions from a disk into a T Tauri star explains a variety of observational peculiarities of FU Orionis objects.

39024 (N—86-21477) Study of travelling interplanetary phenomena (STIP) workshop travel. Final Report. Wu, S.T. (Alabama Univ., Huntsville (USA)). Jan 1986. 46p. (NASA-CR—176544). NTIS, PC A03/MF A01.

Thirty six abstracts are provided from the SCOSTEP/STIP Symposium on Retrospective Analyses and Future Coordinated Intervals held in Switzerland on June 10 to 12, 1985. Six American scientists participated in the symposium and their abstracts are also included. The titles of their papers are: (1) An analysis of near surface and coronal activity during STIP interval 12, by T. E. Gergely; (2) Helios images of STIP intervals 6, B. V. Jackson; (3) Results from the analysis of solar and interplanetary observations during STIP interval 7, S. R. Kane; (4) STIP interval 19, E. Cliver; (5) Hydrodynamic buoyancy force in the solar atmosphere, T. Yeh; and (6) A combined MHD modes for the energy and momentum transport from solar surface to interplanetary space, S. T. Wu. 1 reference.

39025 (N—86-21478) Shock-induced volatile loss from a carbonaceous chondrite: implications for planetary accretion. Tyburczy, J.A.; Frisch, B.; Ahrens, T.J. (California Inst. of Tech., Pasadena (USA)). Jan 1986. 15p. (NASA-CR—176575). NTIS, PC A02/MF A01.

Solid recovery impact-induced volatile loss experiments on the Murchison C2M meteorite indicate that for an impact of a given velocity, H_2O and total volatiles are driven from the sample in the same proportion as present initially. The primitive surface volatile budget of a planet growing by accretion would have the same bulk elemental composition as the volatiles in the incident planetesimals. Incipient devolatilization of Murchison occurs at an initial shock pressure of about 11 GPa and complete devolatilization occurs at a pressure of about 30 GPa. For the Earth, incipient and complete devolatilization of accreting planetesimals would occur when the planet reached approximately 12% and 27%, respectively, of its present-day radius. Impact-induced devolatilization would profoundly affect the volatile distribution within the accreting planet. Prior to metallic core formation and internal differentiation the growing planet would have a very small core with the same volatile content as the incident material, a volatile depleted mantle, and an extremely volatile rich surface. In the case of the Earth, 99.4 wt% of the total incident volatile material would end up on or near the planetary surface.

39026 (N—86-21479) Oblique impact: a process for providing meteorite samples of other planets. Okeefe, J.D.; Ahrens, T.J. (California Inst. of Tech., Pasadena (USA)). Mar 1986. 16p. (NASA-CR—176616). NTIS, PC A02/MF A01.

Cratering flow calculations for a series of oblique to normal impacts of silicate projectiles onto a silicate halfspace were carried out to determine whether the gas produced upon shock vaporizing both projectile and planetary material could entrain and accelerate surface rocks and thus provide a mechanism for propelling SNC meteorites from the Martian surface. The difficult constraints that the impact origin hypothesis for SNC meteorites has to satisfy are that these meteorites are lightly to moderately shocked and yet were accelerated to speeds in excess of the Martian escape velocity. Two dimensional finite difference calculations demonstrate that at highly probable impact velocities, vapor plume jets are produced at oblique impact angles of 25 deg to 60 deg and have speeds as great as 20 km/sec. These plumes flow nearly parallel to the planetary surface. It is shown that upon impact of projectiles having radii of 0.1 to 1 km, the resulting vapor jets have densities of 0.1 to 1 g/cu.cm. These jets can entrain Martian surface rocks and accelerate them to velocities 5 km/sec. It is suggested that this mechanism launches SNC meteorites to Earth.

39027 (N—86-21483) **Martian surface properties. Final Technical Report.** Greeley, R. (Arizona State Univ., Tempe (USA)). Jan 1986. 8p. (NASA-CR—176556). NTIS, PC A02/MF A01.

The objectives were: to characterize surficial geologic units through integration of Infrared Thermal Mapper (IRTM)-derived regolith properties with other existing remote sensing data; to determine the physical and spectral properties of volcanic units in the mid-latitudes of Mars through the synthesis of the highest resolution IRTM, radar, and imaging data available; and to identify and characterize aeolian terrains on Mars using physical surface characteristics determined from remote sensing data.

39028 (N—86-21486) **Two types of flare associated filament eruptions.** Tang, F. (California Inst. of Tech., Pasadena (USA)). Jan 1986. 23p. (NASA-CR—176571; BBSO—0255). NTIS, PC A02/MF A01.

Using years of high resolution solar footage obtained at Big Bear Solar Observatory, flare associated filament eruptions were studied. In addition to the classical type eruption consisting of expansion and breakup, evidence was found of another type where a layer is shed from the filament and erupts while the inversion line filament below (or, what is left of it) remains in place. Both types of eruptions are presented. It is hoped that the new evidence will shed new light on the understanding of the role of filaments in flares.

39029 (N—86-21487) **Ionic charge distributions of energetic particles from solar flares. Semiannual Report, 1 July-31 December 1985.** Mullan, D.J.; Waldron, W.L. (Delaware Univ., Newark (USA)). Mar 1986. 10p. (NASA-CR—176610). NTIS, PC A02/MF A01.

The effects which solar flare x-rays have on the charge states of solar cosmic rays is determined quantitatively. Rather than to characterize the charge distribution by temperature alone, it is proposed that the x-ray flux at the acceleration site also is used. The effects of flare x-rays are modeled mathematically.

39030 (N—86-21492) **Electromagnetic dissociation effects in galactic heavy-ion fragmentation.** Norbury, J.W.; Townsend, L.W. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Feb 1986. 48p. (NASA-TP—2527; L—16033). NTIS, PC A03/MF A01.

Methods for calculating cross sections for the breakup of galactic heavy ions by the Coulomb fields of the interacting nuclei are presented. By using the Weizsacker-Williams method of virtual quanta, estimates of electromagnetic dissociation cross sections for a variety of reactions applicable to galactic cosmic ray shielding studies are presented and compared with other predictions and with available experimental data.

39031 (N—86-22510) **Papers presented to the workshop on the geology and petrology of the apollo 15 landing site.** (Lunar and Planetary Inst., Houston, TX (USA)). 1985. 80p. (NASA-CR—176622; CONF-8511152—Exc.). NTIS, PC A05/MF A01.

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

Samples from Apollo 15 flight were analyzed to develop models for lunar basin formation and evolution, basin geology, petrology, volcanology, stratigraphy, and geochemistry.

39032 (N—86-22510, pp vp) **Apollo 15 mare units and their petrogenesis.** Binder, A.A. 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

Samples from 12 different mare sites were identified and classified among the Apollo 15 samples. The genesis of the Apollo 15 mare units is summarized given the general model of mare basalt source regions and of more basalt genesis derived from a synthesis of the major oxide/major mineral, compatible siderophile, and incompatible trace element data and isotopic ratios of the Rb/Sr and Sm/Nd systems.

39033 (N—86-22510, pp vp) **Comparison of petrology, grain sizes and surface maturity parameters for Apollo 15 regolith breccias and soils.** Bogard, D.D.; Mckay, D.S.; Morris, R.V.; Johnson, P.; Wentworth, S.J. 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

A total of 28 Apollo 15 regolith breccias were analyzed for their petrographic and textural properties and for the surface exposure indices solar noble gases and I (sub s)/Fe 0. Similarities and differences in compositional components and irradiation history were examined between regolith breccias and local, present day soils.

39034 (N—86-22510, pp vp) **Apollo 15 mare volcanism: constraints and problems.** Delano, J.W. 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

The Apollo 15 landing site contains more volcanics in the form of crystalline basalts and pristine glasses, which form the framework for all models dealing with the mantle beneath that site. Major issues on the petrology of the mare source regions beneath that portion of Mare Imbrium are summarized.

39035 (N—86-22510, pp vp) **Hadley Rille, lava tubes and mare volcanism at the Apollo 15 site.** Greeley, R.; Spudis, P.D. (Geological Survey, Flagstaff, AR). 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

Hadley Rille appears to be a collapsed lava tube/channel, whose formation history may be more intimately related to the mare units sampled at 15 than was previously thought. More work is needed relating samples and observations from Apollo 15 to the rille and its geologic evolution. As the only sinuous rille visited during the Apollo missions, Hadley Rille represents a data source that is directly applicable to the deciphering of processes involved in lunar mare volcanism.

39036 (N—86-22510, pp vp) **Geologic history of quartz-normative and olivine-normative basalts in the vicinity of Hadley Rille (Apollo 15).** Grove, T.L. 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

The geologic history of the quartz normative (QNB) and olivine normative (ONB) basalt types at Hadley Rille are discussed. A model for the geology of the mare basalts was constructed from a combination of field observations, sample chemistry, sample petrology and personal bias from terrestrial experience. The model proposes that the QNBs are the only mare lava type that is present as outcrop in the area traversed by the astronauts during the Apollo 15 mission. The returned QNB samples formed during a single

eruptive phase of the Hadley Rille lava tube system. The ONB lavas are an exotic component transported to the site by a cratering event, or the ONBs are samples excavated from older are bedrock that was partly covered by the QNB lavas.

39037 (N—86-22510, pp vp) **Petrology and geochemistry of highlands samples from the Apennine Front.** Lindstrom, M.M. 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

Individual rocks from the Hadley Delta massif, part of the Apennine Front, are described beginning with the simplest samples to the most complex breccias. Relationship among the samples were evaluated. Geological interpretations of the samples were speculative because of the limited data set, but provided models to be tested when additional data are available.

39038 (N—86-22510, pp vp) **Ultramafic parent magmas for mare basalts.** Longhi, J. 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

Solidification products of basaltic magmas (fine grained basalts and ultramafic glasses) at the Apollo 15 site were examined. Consideration of simple MgO-$6IO_2$-Al_2O_3 systematics plus results of calculations of fractional crystallization was reviewed. Suggestions are presented to account for the lack of correlation between the ultramafic glasses and basalts.

39039 (N—86-22510, pp vp) **Spectral reflectance study of the Hadley-Appenine (Apollo 15) region.** Lucey, P.G.; Hawke, B.R. 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

Twenty three near infrared spectra were obtained from the Mauna Kea Observatory 2.2 m telescope. Results of an analysis of near infrared spectra obtained for surface units in the Hadley-Apennine region were presented. Compositional trends from the interior to exterior of the Imbrium are discussed.

39040 (N—86-22510, pp vp) **Samples at the Apollo 15 landing site: types and distribution.** Ryder, G. 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

Samples, consisting of more than 350 individually numbered samples of rock and regolith, were collected during the three EVAs on the Apollo 15 mission. Samples consisted of rock specimens, and scooped, trenched, and cored regolith samples. Petrographic and chemical analysis are discussed.

39041 (N—86-22510, pp vp) **Apennine Bench Formation revisited.** Spudis, P.D.; Hawke, B.R. (Hawaii Univ., Honolulu). 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

The Apennine Bench Formation consists of pre-mare light plains materials that crop out south of the crater Archimedes, inside the Imbrium basin. This material was ascribed to either impact or volcanic origins. The characteristics of Apollo 15 KREEP basalts and the Apennine Bench Formation are reviewed to determine whether their characteristics are compatible with a volcanic origin.

39042 (N—86-22510, pp vp) **Origin of pristine KREEP: Effects of mixing between ur KREEP and the magmas parental to the MG-rich cumulates.** Warren, P.H. 1985. NTIS, PC A05/MF A01. (NASA-CR—176622; CONF-8511152—Exc.).

From Shuttle environment and operations II conference; Houston, TX, USA (13 Nov 1985).

The magnesium/incompatible elements paradox is explained by a model that considers not only the magmasphere, but also its aftermath. A systematic mixing of primitive magnesium rich material with residual liquid is discussed as a method to account for the paradox that KREEP basalts, despite their high incompatible element contents, have moderate magnesium ratios. The KREEP basalts are compared with mare basalts.

39043 **(PB—86-179199/XAB) Solar-Geophysical Data Number 490, June 1985. Part 2 (comprehensive reports). Data for December 1984, March-May 1983, and miscellanea (reannouncement of PB86-121993 - see notes field for explanation).** Coffey, H.E. (National Geophysical Data Center, Boulder, CO (USA)). Jun 1985. 92p. (SGD—490-PT-2). NTIS, PC A05/MF A01.

Contents include: Detailed index for 1984-1985; Data for December 1984--(Meudon Carte Synoptique, Solar radio bursts at fixed frequencies, Solar X-ray radiation from GOES satellite graphs, Mass ejections from the sun, Active prominences and filaments, Solar irradiance); Data for March, April and May 1983--(Solar flares March 1983, Solar flares April 1983, Solar flares May 1983, Number of flares August 1966 - May 1983).

39044 **(PB—86-180643/XAB) Ion-release experiments in the solar wind.** Bryant, D.A. (Rutherford Appleton Lab., Chilton (UK)). Oct 1985. 13p. (RAL—85-094). NTIS, PC A03/MF A01.

In a new departure in experimental space plasma physics, lithium and barium plasmas were injected into the solar wind approximately 110,000 km above the Earth's surface. The effects, monitored in-situ by two spacecraft of the AMPTE (Active Magnetospheric Particle Tracer Explorers) mission, included the formation of diamagnetic cavities, a slowing down locally of the solar wind, generation of plasma waves, and heating of solar-wind electrons. These comet-like interactions between the solar wind and obstacles presented by the injected plasmas are discussed and compared with the effect of the natural obstacle of the Earth's magnetosphere first encountered by the solar wind at the bow shock. Particular reference is made to the artifical comet created by a barium-ion release on 27 December 1984.

39045 **Non-Abelian symmetries from higher dimensions in string theories.** Nepomechie, R.I. (Department of Physics, FM-15, University of Washington, Seattle, Washington 98195). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 12, 3670-3677(15 Jun 1986). Contract AC06-81ER40048.

A bosonic string model with G x G gauge excitations can be understood as the dimensional reduction of a simpler string model in higher spacetime dimensions. It follows that the corresponding effective low-energy theories of these two models are similarly related. A close relationship of these bosonic strings to the heterotic string model is also noted.

39046 **Muon production by photons from Cygnus X-3.** Coteus, P.; DeGrand, T. (Department of Physics, University of Colorado, Boulder, Colorado 80302). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3279-3282(1 Jun 1986).

We perform an analytic calculation of TeV-muon production by photons interacting in the atmosphere. The model used contains all the relevant physical properties of this system. We derive several useful approximate scaling relations for muon production. Using the measured photon spectrum from Cygnus X-3 we predict a rate of 2.2×10^{-13} events/cm^2 sec for muon energies exceeding 0.6 TeV, a factor of 320 below the recent Soudan measurement.

39047 **Solar neutrinos from the decay of ^{8}B.** Bahcall, J.N.; Holstein, B.R. (Institute for Advanced Study, Princeton, New Jersey 08540). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 2121-2127(Jun 1986).

The spectrum of neutrinos produced by the beta decay of ^{8}B in the sun is computed including forbidden corrections to the weak interactions. The total cross section for absorption by ^{37}Cl of ^{8}B neutrinos is $(1.06 \pm 0.1) \times 10^{-42}$ cm^2. The uncertainty is determined by calculating the cross section using different measured spectra for the alpha particles that result from the decay of ^{8}B to ^{8}Be and by varying the transition matrix elements consistent with

the branching ratios measured using delayed protons emitted in the beta decay of ^{37}Ca.

39048 **Two-point correlation for rich clusters of galaxies.** Otto, S.; Politzer, H.D.; Wise, M.B. (California Institute of Technology, Pasadena, California 91125). *Physical Review Letters;* **56**: No. 17, 1878-1881(28 Apr 1986). Contract AC03-81ER40050;AS03-83ER13118;FG03-84ER40172.

The rich-cluster two-point correlation function is examined in a model where rich clusters of galaxies form at high peaks of primordial Gaussian mass-density fluctuations (averaged over a suitable volume). Particular attention is paid to the case when the primordial fluctuations have a Zel'dovich spectrum.

39049 **Simulation of the solar wind interaction with the outer regions of the coma.** Omidi, N.; Winske, D. (Institute of Geophysics and Planetary Physics, Univeristy of California, Los Angeles). *Geophysical Research Letters;* **13**: No. 4, 397-400(Apr 1986).

Interaction of the solar wind with newly born cometary ions (0^+) is studied through hybird simulations (particle ions, fluid electrons). The results show that depending on the orientation of the interplanetary magnetic field (IMF) with respect to the solar wind velocity, two kinds of interaction are possible. When IMF is exactly or nearly parallel to the solar wind velocity, momentum transfer between the protons and the 0^+ ions takes place solely through the excitation of large amplitude electromagnetic waves. On the other hand, as IMF becomes more oblique to the solar wind velocity, momentum transfer occurs on a faster time scale through the motional electric field in the solar wind. This more rapid deceleration can lead to the formation of a shock.

39050 **Interaction of heavy ions from comet P/Giacobini-Zinner with the solar wind.** Sanderson, T.R.; Wenzel, K.; Daly, P.; Cowley, S.W.H.; Hynds, R.J.; Smith, E.J.; Bame, S.J.; Zwickl, R.D. (Space Science Department of ESA, Estec, Noordwijk). *Geophysical Research Letters;* **13**: No. 4, 411-414(Apr 1986).

The encounter between the ICE spacecraft and Comet P/Giacobini-Zinner was characterized in the solar wind by intense fluxes of heavy ions, measurable over a region 6×10^6 km in extent. The ions are observed with highly anisotropic angular distributions, steep energy spectra, and a change in the energy spectrum at around 80 keV, consistent with a composition predominantly of the water group. Flux versus time profiles follow a general fall off with increasing distance from the comet but with a marked inbound/outbound asymmetry. This asymmetry is due to the higher solar wind velocity on the outbound pass, giving rise to an increased energy gain of the pick-up ions. The flux versus time profiles are strongly modulated by the rapid changes in the direction of interplanetary magnetic field. We present correlated observations of energetic ions, the interplanetary magnetic field and the solar wind, and compare these observations with theoretical predictions of the ion pick-up process.

39051 **Model of Comet P/Giacobini-Zinner.** Boice, D.C.; Huebner, W.F.; Keady, J.J.; Schmidt, H.U.; Wegmann, R. (T-4, Los Alamos National Laboratory). *Geophysical Research Letters;* **13**: No. 4, 381-384(Apr 1986).

A computer model of Comet P/Giacobini-Zinner is presented which contains photo-processes, gas-phase chemical kinetics, energy balance. Multifluid hydrodynamics with a transition to free molecular flow, and solar wind interaction. Recently, the physics for electrons in the model has been improved by including electron impact ionization and dissociation and separately accounting for electron energetics. Electron heating and cooling mechanisms include photoprocesses, recombination processes, inelastic and elastic collisions with heavy molecules, and expansion cooling. The model incorporates an internally consistent interaction of the solar wind with the coma gas using the axisymmetric ideal fluid dynamic equations. The nuclear size and composition have been chosen to make the calculations relevant to the 11 September 1985 International Cometary Explorer (ICE) encounter with Comet P/Giacobini-Zinner. Model profiles of the temperature, velocity, and number density of the electrons are in good agreement with measurements along ICE's trajectory. These results indicate that the probe passed through a region of the coma at the onset of the plasma tail.

39052 **Three component plasma electron distribution in the intermediate ionized coma of comet Giacobini-Zinner.** Zwickl, R.D.; Baker, D.N.; Bame, S.J.; Feldman, W.C.; Fuselier, S.A.; Huebner, W.F.; McComas, D.J.; Young, D.T. (University of California, Los Alamos National Laboratory, Los Alamos, NM 87545). *Geophysical Research Letters;* **13**: No. 4, 401-404(Apr 1986).

On 11 September, 1985, the interval from 1056 to 1110 UT surrounding closest approach (i.e. within -1.2×10^4 km), ICE encountered a region characterized by an unusually low electron temperature, a high density, a bulk flow speed $V < 30$ km/s, and a relatively low level of plasma turbulence. We call this region the intermediate ionized coma, IIC. Electron velocity distribution functions in the IIC are composed of three distinct components: cold, mid, and hot. We believe that the cold population represents electrons produced close to the comet nucleus by ionization of cometary matter and subsequent cooling by Coulomb collisions. The mid distribution also appears to be composed of electrons produced by photoionization of cometary neutrals, but sufficiently far from the comet nucleus that the distributions are largely unaffected by Coulomb interactions. Thus the mid population is not in thermal equilibrium with the cold distribution. The temperature of the mid distribution compares well with the average energy of electrons resulting from the ionization of H_2O, which leads us to conclude that the composition of the ion population at this distance is consistent with the intepretation that H_2O is the dominant species. The hot component is most likely a population of electrons of solar wind origin. Throughout the IIC the electrostatic potential of the spacecraft was very low (<0.8 eV), implying ICE generated very little impact-produced plasma during its passage.

39053 **Comet/solar wind transition region at Giacobini-Zinner.** Thomsen, M.F.; Bame, S.J.; Feldman, W.C.; Gosling, J.T.; McComas, D.J.; Young, D.T. (Los Alamos National Laboratory, Los Alamos, NM 87545). *Geophysical Research Letters;* **13**: No. 4, 393-396(Apr 1986).

Between about 7 and 12×10^4 km from the nucleus of Comet Giacobini-Zinner, the International Cometary Explorer (ICE) found a region in which the solar wind flow speed decreased and the electron density and temperature increased by factors of ~ 2. This transition region was characterized by large fluctuations in the plasma parameters and by highly variable electron velocity distributions. Electron temperature and density variations through the transition region reveal that ICE never crossed a short-scalelength bow shock during the encounter, although the scalelength for the gross transition in plasma properties is not incompatible with a shock dominated by the length scales of cometary ions. However, many of the electron distributions in the transition region and sheath are similar to those seen behind weak collisionless shocks elsewhere in the heliosphere. A model of the comet/solar wind interaction is suggested in which a standing shock exists sunward of the ICE trajectory, but, due to large variations in the upstream conditions, it is highly variable and perhaps only intermittent along the flanks.

39054 **Search for the interstellar HCN dimer.** Schenewerk, M.S.; Snyder, L.E.; Jewell, P.R.; Buxton, L.W.; Campbell, E.J. (Illinois Univ., Urbana; National Radio Astronomy Observatory, Tucson, AZ; G. B. Du Pont Co., Inc., Parkersburg, WV; Los Alamos National Lab., NM). *Astrophysical Journal;* **296**: 218-221(Sep 1985).

An unsuccessful search was made for emission from the vibrational ground state of the interstellar HC-12N-14 dimer in nine sources. The (HCN)2 search results reported earlier by other groups were for a vibrationally excited state; hence, this is the first reported attempt to detect the vibrational ground state. Upper limits to the (HCN)2 column density per unit velocity were calculated for each source, and a comparison to HCN data for Orion A was made which suggests that the abundance of the HCN dimer is significantly less than that of the monomer. One unidentified line was detected and is reported here with a tentative identification. 18 references.

39055 **Resonant absorption, hot electrons, and cosmic gamma-ray bursts.** Liang, E.P. (Lawrence Livermore National Lab., CA). *Astrophysical Journal;* 283: No. 1, L21-L23(1 Aug 1984). Contract W-7405-ENG-48.

It is proposed that resonant absorption of intense electromagnetic waves impinging onto a neutron star surface during a magnetic flare is the source of the hot electrons whose synchrotron radiation leads to γ-ray bursts. Parameters of the emission layer derived from first principles generally agree with empirical values. The luminosity-temperature scaling law observed by the KONUS experiment, if confirmed, may also be explained by this picture.

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REFER ALSO TO CITATION(S) 38773, 39044

39056 **(AD-A—166066/1/XAB) Control of magnetospheric convection by the spatial distribution of ionospheric conductivities.** (SRI International, Menlo Park, CA (USA)). 1 Jan 1986. 25p. NTIS, PC A02/MF A01.

A self-consistent semianalytical model of magnetospheric convection including the effect of conductivities is presented. The motions of the inner edge of the magnetospheric ring current, and the associated field-aligned currents, produced by the externally imposed dawn-to-dusk potential drop across the magnetospheric cavity are computed by using a linear approximation. The coupling between the different diurnal harmonics in the local time variations of fields and currents produced by the local time dependence of ionospheric conductivities is described by an appropriate matrix formalism. The calculations show that the enhancement of auroral conductivities by electron precipitation in the auroral zone signficantly enhances both the typical duration and the absolute amplitude of the penetration of convection electric fields to midlatitudes. Furthermore, the local time variations of the convection electric field generated at midlatitudes by a sudden increase of the dawn-to-dusk potential drop are in good agreement, both at the initial time and after the steady state is reached, with the available statistical models of the disturbance midlatitude electric field.

39057 **(AD-A—166431/7/XAB) Convective stabilization of ionospheric plasma clouds. Memorandum report.** Drake, J.F.; Huba, J.D. (Naval Research Lab., Washington, DC (USA)). 19 Mar 1986. 47p. (NRL-MR—5722). NTIS, PC A03/MF A01.

Stability criteria are derived for the large-scale structuring of ionospheric plasma clouds due to the E X B gradient drift instability. For the equilibrium a cylindrical 2D waterbag cloud aligned along a uniform magnetic field polarized by a neutral wind is considered. A stability analysis is performed that allows three-dimensional perturbations (in r, theta, and z), and consider both local and global modes. It was found that when the parallel wavenumber k/ sub z/ exceeds a threshold value, exponentially growing global eigenmodes form that are localized on the backside of the cloud. This is in contrast to the k/sub z/ = 0 limit in which there are no exponential solutions. As k/sub z/ is increased further, the unstable modes localize at a finite angle away from the backside; at a point where the diamagnetic propagation velocity (V/sub d/) balances the convective-flow velocity of the background plasma around the cloud (V sub b). It was found that the E X B gradient drift instability is stable when V/sub d/ > V/sub b/ so that the cloud is no longer susceptible to large-scale structuring.

39058 **Digital ionosonde observations during equatorial spread F-italic.** (Atmospheric Sciences Group, Earth and Space Sciences Division, Los Alamos National Laboratory, Los Alamos, New Mexico). *Journal of Geophysical Research;* 91: No. A5, 5539-5556(1 May 1986).

In this paper we present and discuss equatorial spread F-italic data taken with a digital ionosonde/HF radar located at Huancayo, Peru. A modified phenomenology is developed which uses the system's ability to do echo location. The onset of irregularities is seen to occur in the east and to move westward, while inside this large-scale structure the plasma is found to drift eastward. A very curious difference has been identified between spread F-italic observations with the ionosonde and with the VHF radar at Jicamarca. At VHF, spread F-italic onset often occurs when the ionosphere is rising, whereas in all five examples presented here, the digital ionosonde detected onset when the apparent ionosphere motion was downward. The result even held on the one night of common data taking. The effect could be instrumental but may be related to the considerable orographic differences in the two sites. Isolated scattering patches are observed and are tentatively identified as detached or "fossil" plumes. At frequencies above the nominal f-italic$_0$F-italic$_2$ the system (and other ionosondes) may in fact function as a coherent radar. During one night, data were obtained simultaneously with the HF radar, a rocket, and the Jicamarca VHF radar. Comparisons of these data are discussed in detail. Finally, additional evidence is presented that acoustic gravity waves play a role in the development of equatorial spread F-italic and in the formation of detached plumes. To be self-consistent, the gravity waves must come from nearby sources such as the tropical rain forest to the east of Jicamarca.

39059 **Electrical changes of the polar ionosphere during magnetospheric substorms.** (Department of Earth Science, Teachers College, Kyungpook National University, Taegu, Korea). *Journal of Geophysical Research;* 91: No. A5, 5737-5754(1 May 1986).

Changes of the distribution of the potential, electric fields, ionospheric currents, field-aligned currents, the Joule heat production rate, the particle energy injection rate and the total energy dissipation rate are examined in detail by comparing them at a presubstorm epoch and the maximum epoch for several substorms on March 17, 18, and 19, 1978. The data sets are obtained on the basis of the magnetic records from the six International Magnetospheric Study meridian chains of observatories by using the computer code developed by Kamide e-italict-italic a-italicl-italic. (1981) and the conductivity model developed by Ahn et al. (1983b). A number of global features that are found to be common to most of the substorms examined in this study include the following: (1) The positive potential cell in the morning sector extends into the evening sector during substorms. (2) When it is intensified, the westward electrojet on the nightside tends to flow equatorward of the positive potential ridge. (3) The so-called "Harang discontinuity" may be identified as the ridge of the negative potential cell. (4) The distribution of field- aligned currents determined by our method is more complicated than the statistical pattern obtained by polar orbiting satellites. (5) The basic ionospheric current pattern is fundamentally the same during a fairly quiet period, a slightly disturbed period and a substorm period. (6) The highest Joule heat production occurs along the westward extension of the westward electrojet, while the particle energy injection rate is high along the westward electrojet in the morning sector.

39060 **Strong electron bidirectional anisotropies in the distant tail: ISEE 3 observations of polar rain.** (Los Alamos National Laboratory, Los Alamos, New Mexico). *Journal of Geophysical Research;* 91: No. A5, 5637-5662(1 May 1986).

A detailed observational treatment of bidirectional electrons (—50 to 50 eV)in the distant magnetotail (r-italicapprox. >100 R-italic/sub E-italic/) is presented. It is found that electrons in this energy range commonly exhibit strong, field-aligned anisotropies in the tail lobes. Because of large tail motions, the ISEE 3 data provide extensive sampling of both the north and south lobes in rapid succession. These data demonstrate directly the strong asymmetries that exist between the north and south lobes at any one time. The bidirectional fluxes are found to occur predominantly in the lobe directly connected to the sunward interplanetary magnetic field in the open magnetosphere model (north lobe for away sectors and south lobe for toward sectors). Electron anisotropy and magnetic field data are presented which show the transition from unidirectional (sheath) electron populations to bidirectional (lobe) populations. Thus we demonstrate the open nature of the distant magnetopause and show that the source of the higher-energy, bidirectional lobe electrons is the tailward directed electron heat flux population in the distant magnetosheath. Taken together, the present evidence suggests that the bidirectional electrons that we observe in the distant tail are closely related to the polar rain electrons observed previously at lower altitudes. Furthermore, these data provide strong evidence that the distant tail is composed largely of open magnetic field lines in contradistinction to some recently advanced models.

39061 **ISEE observations of the plasma sheet boundary, plasma sheet, and neutral sheet: 1, Electric field, plasma, and ion composition.** (Space Sciences Laboratory, University of California, Berkeley). *Journal of Geophysical Research;* 91: No. A5, 5663-5680(1 May 1986).

The first simultaneous study of dc and ac electric and magnetic fields, E x B velocity, plasma flows, β, total energy density, energetic particles, and ion composition from the ISEE satellites and ground and interplanetary magnetic fields has been made to determine (1) the relationship of the previously observed electric fields at the plasma sheet boundary and at the neutral sheet to plasma parameters, and (2) whether the phenomena occurring during quiet and active times were consistent with the formation of a near-earth neutral line during substorms or with the boundary layer model. The following observations during the two substorms studied are in agreement with predictions of the neutral-line model: (1) the buildup of energy stored in the tail magnetic field for 1-2 hours prior to onset, followed by its rapid decrease after onset, (2) the enhanced convection of magnetic field lines and plasma into the neutral sheet from above and below as indicated by the E x B velocity, (3) tailward convection of field lines and plasma (E-italic/sub y/(dawnward and duskward) and B-italic/sub z-italic/ (northward and southward) anticorrelated in sign) at onset, followed by thinning of the plasma sheet, and then convection earthward (E-italic/sub y-italic/ and B-italic/sub z-italic/ correlated in sign) during recovery of the plasma sheet, (4) repeated encounters with the neutral sheet during the times of the large electric fields and fast plasma flows, indicating that both existed throughout the plasma sheet and not just at the boundary and that the substorm-associated phenomena were initiated (5) heating of electrons in association with fast tailward flow and southward B-italic/sub z-italic/.

39062 **ISEE observations of the plasma sheet boundary, plasma sheet, and neutral sheet: 2, Waves.** (Space Sciences Laboratory, University of California, Berkeley). *Journal of Geophysical Research;* 91: No. A5, 5681-5688(1 May 1986).

The companion paper describes the dc electric and magnetic fields, E x velocities, plasma flow, composition and ground magnetic activity for two periods in the magnetotail near 20 R-italic/sub E-italic/. The relationship of the plasma waves to the dc field characteristics is described herein. In addition, for two subintervals which had strong ground magnetic activity, we report comparisons of plasma waves in the magnetotail to characteristics of the dc fields and fluid parameters such as the plasma flow, β, density, temperature, and f-italic/sub p//sub e//f-italic/sub c//sub e/. Upper hybrid waves at multiples of the electron cyclotron frequency near and above the electron plasma frequency were observed for the first time in this region of the magnetosphere and occurred in regions of low β and temperature and high density. This contrasts with electrostatic electron cyclotron waves which occurred in high temperature, high-density regions, as previously reported by Gurnett et al. (1976), and were suppressed when β approx. < 1. Both types of waves were associated with small dc electric fields, nonturbulent dc electric and magnetic fields, and plasma flows of approx. <100 km/s. Broadband electrostatic noise (BEN) and magnetic noise bursts were observed in regions where the dc electric fields and the plasma flows were large, and the dc electric and magnetic fields were turbulent. The dependence of the amplitude and frequencies of BEN on the magnitude of the magnetic field, plasma flow, density, and β was very complex. Enhancements at the upper hybrid frequency and the electron cyclotron frequency were common. Ben was usually suppressed near the neutral sheet but the amplitude reduction varied.

39063 **High-energy proton drift echoes: multiple peak structure.** Belian, R.D.; Baker, D.N.; Hones, E.W.; Higbie, P.R. (Los Alamos National Lab., NM). *Journal of Geophysical Research;* 89: No. A10, 9101-9106(1 Oct 1984).

Many high-energy proton drift echoes observed in association with magnetospheric substorms exhibit multiple fine-structure peaks during the course of one or more of the echoes. Because of the difficulty in distinguishing between temporal, positional, pitch angle selection, and drift shell effects with instruments on a single satellite the identification of these as individual entities (as opposed to statistical variations in proton intensity or other effects) has not been convincingly established heretofore. The energetic ion data from similar instruments on three widely spaced geosynchronous satellites have been examined with the goal of establishing whether or not these multiple peaks are a persistent feature of the injection process. The results suggest that multiple peaks are indeed a real feature of drift echoes. At least three quarters of the ion enhancements that result in drift echoes are made up of multiple-peaked events. A very good correlation between the onset of the various peaks and detailed features observed in high-latitude magnetograms is observed for some of the multiple peaked events. In fact, in their relation to the magnetograms, there seems to be a pairing of pulses; that is, with some dips in the magnetogram there appears to be two associated pulses. Various possible models for the production of multiple peaks, including the ion tearing mode instability in the plasma sheet, magnetic mirroring effects, temporal and/or positional effects of multiple neutral line formation, and effects due to different ion species are discussed. 17 references, 4 figures, 1 table.

39064 **Direct observations of passages of the distant neutral line (80-140 R/sub E/) following substorm onsets: ISEE-3.** Baker, D.N.; Bame, S.J.; Birn, J.; Geldman, W.C.; Gosling, J.T.; Hones, E.W. Jr.; Zwickl, R.D.; Slavin, J.A.; Smith, E.J.; Tsurutani, B.T.; Sibeck, D.G. (Los Alamos National Lab., NM). *Geophysical Research Letters;* 11: No. 10, 1042-1045(Oct 1984).

Detailed plasma and field data are examined for a period of time when ISEE-3 is in the range -140 approximately $<$ X/sub GSM/ approximately $<$ -80 R/sub E/. Several clear examples, at a frequency of $\sim$ once per day, of strong southward magnetic field followed by strong northward field occur when OSEE-3 is in the plasma sheet. During the southward field intervals, the bulk plasma flow is strongly tailward while during the northward field episodes the plasma flow is generally very weak. In all instances of this kind, the signatures at ISEE-3 follow (by 5-10 minutes) the initial impulsive injection of energetic ions at geostationary orbit. It is suggested that the south-to-north field transitions and plasma flow patterns are produced by the passage over ISEE-3 of the distant neutral line immediately following near-earth substorm onset. 12 references, 3 figures.

39066 **Observation of a heated electron population associated with the 6300A SAR arc emission.** Gurgiolio, C.; Slater, D.W.; Winningham, J.D.; Burch, J.L. (Southwest Research Inst., San Antonio, TX). *Geophysical Research Letters;* 9: No. 9, 965-968(Sep 1982). Contract AC06-76RL01830.

Conjunctive observations of the Dynamics Explorer satellite pair and the Pacific Northwest Laboratory scanning photometer unit at Richland, WA have allowed identification of the low energy, heated, electron population associated with the 6300A SAR arc emission. Measurements over the SAR arc on day 296 of 1981 show an enhanced flux in the low altitude 5-12 ev electrons. Analysis of this electron population shows them to be fairly Maxwellian with temperatures on the order of 9900 +/- 1100°K and an earthward field aligned velocity of approximately 275 +/- 60 km/sec. The electrons are not accompanied by ion precipitation. The ion loss cone is empty at least as high as 6000 km. This fact may cast some doubt as to the role of the ring current ions in the SAR arc production. 11 references, 4 figures.

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REFER ALSO TO CITATION(S) 37749, 38400, 38403, 38487, 38512, 38576, 38603, 38683, 38694, 38716, 38741, 39112, 39151, 39299

39098 **(AD-A—166167/7/XAB) Intense beam of metastable H_2 molecules.** Garvey, J.F. (California Inst. of Tech., Pasadena (USA). Arthur A. Noyes Lab. of Chemical Physics). 15 Jun 1984. 6p. NTIS, PC A02/MF A01.

A method is described for generating a hyperthermal beam of metastable H_2 molecules, intense enough for scattering and absorption spectroscopy experiments. From the flight time of these species between source and detector, it is estimated that their lifetime exceeds 40 microsec and that they are in the 2p2A state.

39067 (AD-A—166261/8/XAB) Temperature dependence of diffracted-beam intensities in atom-surface scattering. Annual technical report. (California Univ., Santa Barbara (USA). Quantum Inst.). Feb 1986. 10p. (TR—9). NTIS, PC A02/MF A01.

We develop a new method for the calculation of the atom-scattering analog of the Debye-Waller factor. Unlike x-ray and neutron scattering, the properties of an atom scattered by a solid surface cannot be computed by perturbation theory; therefore, the simple Debye-Waller theory cannot be applied. Nevertheless the Debye-Waller phenomenon has a close analog: the elastic intensity is depressed due to the uncorrelated part of the thermal motion of the lattice atoms. To compute this effect, a time-dependent scattering theory is developed in which the quantum properties of the scattered atom are described by propagating coherently an ensemble of wave packets and lattice motion is simulated by a classical Langevin equation. Applications are made to He and Ne scattering from a surface whose lattice dynamics mimics that of Pt(111) but whos corrugation was slightly increased to enrich the diffraction structure.

39068 (AD-A—166275/8/XAB) Mean-trajectory Gaussian wave-packet approach to rotationally inelastic molecule-surface diffraction. Annual report. (California Univ., Santa Barbara (USA). Quantum Inst.). Feb 1986. 42p. (TR—10). NTIS, PC A03/MF A01.

The rotationally inelastic diffraction of H_2 from a corrugated surface is investigated using a mean-trajectory model. The center-of-mass motion is treated using Gaussian wave packets, which propagate on a rotationally averaged potential. This trajectory in turn drives the rotational transitions. The method is nonperturbative and allows for changes in mj, the rotational orientation, and agrees well with recent close-coupling calculations. A connection is also made with the recent semiclassical trajectory work of DePrito. The effects of the attractive well depth on rotational excitation and diffraction are considered.

39069 (AD-A—166291/5/XAB) Multiple Gaussian wave-packet theory of H_2 diffraction and rotational excitation by collision with solid surfaces. Annual report. (California Univ., Santa Barbara (USA). Quantum Inst.). Feb 1986. 43p. (TR—11). NTIS, PC A03/MF A01.

The Gaussian wave packets and the coupled channel method are combined to develop a theory of H_2 diffraction and rotational excitation by collision with surfaces. This improves our previous work on H_2 diffraction since it eliminates the mean trajectory approximation; it also extends Heller's work to problems in which the dynamics require the creation of new packets which must be coupled to each other as they are propagated through the interaction region. The approximations involved in the above Gaussian wave-packet approach can be removed by using extending method proposed by Flect, Morris and Felt, which propagates the Gaussian wave function exactly and efficiently.

39070 (CONF-8604208—1) Geometrical energy derivative evaluation with MRCI wave functions. Shepard, R. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012112.

From Utah-Sanibel symposium on the interface between electronic structure and dynamics; Salt Lake City, UT, USA (21 Apr 1986).

The theory of MCSCF and CI energy derivatives with respect to geometrical variations is briefly reviewed with special attention given to the MCSCF and MRCI energy gradients. A computational procedure is proposed for MRCI energy gradients that does not require the solution to any "coupled-perturbed MCSCF" equations, it does not require any expensive direct-CI matrix-vector products involving derivative integrals, and it does not require any derivative integrals to be transformed from the AO basis to the MO basis. An additional feature is that it does not require any changes to existing MCSCF gradient evaluation programs in order to compute MRCI gradients. The only difference in the two cases is the exact nature of the data passed to the gradient evaluation program from the previous steps in the computational procedure. The additional effort required to compute the entire MRCI energy gradient vector is approximately that required for one additional iteration of the MRCI diagonalization procedure and for one additional MCSCF iteration. For large scale MRCI wave functions, the MRCI energy gradient should only require about 10% of the effort of computing the wave function itself. This computational procedure removes a major computational bottleneck of potential energy surface evaluation. 7 refs.

39071 (DOE/ER/45050—1) Properties of molecular solids and fluids at high pressures and temperatures. [Final report]. Etters, R.D. (Colorado State Univ., Fort Collins (USA). Dept. of Physics). 1985. Contract AC02-84ER45050. 47p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012509.

Equilibrium structures and orientations, lattice vibrational and librational model frequencies, intramolecular vibron mode frequencies, sound velocities, equations of state, compressibilities, and structural and orientational phase transitions in molecular solids are determined over a wide range of pressures and temperatures. In the high temperature fluid phase the equations of state, vibron frequencies, the melting transition, specific heats, compressibilities, second virial coefficients, viscosities and other transport properties, and the nature of orientational and magnetic correlations are determined. The techniques used include several strategies to optimize multi-dimensional functions as a means to determine equilibrium structures and orientations, self consistent phonon lattice dynamics methods, constant pressure and constant volume Monte-Carlo strategies with continuously deformable boundary conditions, mean field approximations, and classical perturbation methods. Systems studied include N_2, O_2, CO, CO_2, F_2, N_2O, benzine, nitromethane, HCL, HBr, and H_2. 50 refs., 4 figs.

39072 (LA-UR—86-1423) Vacuum ultraviolet photolysis of acetylene in the 110- to 135-nm region. Tiee, J.J.; Sander, R.K.; Quick, C.R.; Estler, R. (Los Alamos National Lab., NM (USA); Fort Lewis Coll., Durango, CO (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-8603127—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010202.

From American Institute of Physics conference; Monterey, CA, USA (1 Mar 1986).

State-specific photofragmentation of acetylene in the 110- to 135-nm region has been studied using vuv laser and synchrotron sources. Investigations have been focused on learning the spectroscopic identity of the excited photoproducts by examining their time-resolved fluorescence. Results of the quenching of the excited photofragment emission and the emission polarization measurements are presented. An interpretation of these results in relating the observed photoproducts to the vuv photodissociation process is discussed. 13 refs., 3 figs., 1 tab.

39073 (LA-UR—86-1943) CO/sub 2/ laser sustained CW discharge atomic beam source. Cross, J.B.; Cremers, D.A.; Spangler, L.H.; Hoffbauer, M.A.; Archuleta, F.A. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 11p. (CONF-860636—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012383.

From 15. international symposium on rarefied gas dynamics; Grado, Italy (16 Jun 1986).

A high pressure, supersonic, laser sustained plasma nozzle beam source has been developed for the production of intense ($>10^{19}$ particles s^{-1}-sr^{-1}) beams of atomic and/or radical species having kinetic energies in the range of 1 to 10 eV. A high plasma temperature (10 to 30,000 K) is produced in the throat of a hydrodynamic expansion nozzle by sustaining a cw optical discharge in a gas using a high power cw CO_2 laser. Gas mixtures are expanded through the nozzle/discharge region creating energetic atoms and molecules. An oxygen atom beam has been produced with a kinetic energy of 2 to 3 eV and an intensity of $\sim 10^{18}$ O-atoms $s^{-1}sr^{-1}$. O-atom collisions (1 eV) from an uncharacterized nickel surface shows strong specular scattering with approximately 50% energy loss to the surface. Argon beams having kinetic energies between 5 to 10 eV with intensities of $>10^{19}$ atoms $s^{-1}sr^{-1}$ have also been produced. 13 refs., 8 figs.

39074 (PB—86-179520/XAB) Vuv (vacuum-ultraviolet) and x-ray sources for atomic and molecular science. Final report. (National Research Council, Washington, DC (USA)). 1986. 84p. NTIS, PC A05/MF A01.

The National Research Council's Committee on Atomic and Molecular Sciences (CAMS) convened a workshop on November 8-9, 1984, to review the current status of short-wavelength light sources of interest to the atomic, molecular, and optical (AMO) physics community. The general intent of the Committee was to (1) review advantages and disadvantages of existing technologies in the ultraviolet (uv) and x-ray spectral range, and (2) determine which of these technologies, if any, is best suited for particular problems in AMO physics. Workshop Papers titles are the following: Atomic and molecular physics with vuv and x-ray photons; Properties of synchrotron radiation from bending magnets, wigglers, and undulators; Partially coherent x rays from modern storage rings; Lasers in the vacuum ultraviolet and x-ray region; Laser produced plasma light sources; and Free electron lasers for the xuv spectral region.

39075 (PNL-SA—13602) Charge transfer and ionization occurring in proton- and helium ion-atom collisions. DuBois, R.D. (Pacific Northwest Labs., Richland, WA (USA)). Dec 1985. Contract AC06-76RL01830. 18p. (CONF-860148—8). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012647.

From 2. United States/Mexico cooperative symposium on atomic and molecular physics; Cocoyoc, Mexico (1 Jan 1986).

Two examples are presented where specific channels have been identified that are responsible for single and double target ionization via direct coulomb ionization or charge transfer processes. Using ratios of absolute cross sections that have been measured for these processes it was shown that an independent electron model should be appropriate for calculating direct double target ionization but generally appears to be inadequate in calculating charge transfer plus ionization and double charge transfer cross sections. At present such detailed information can be obtained only in limited cases. However cross sections with detailed final charge state information should provide stringent tests for present and future theoretical work. 22 refs., 2 figs.

39076 (UCRL—94096) Measured 1 to 40 keV photoabsorption cross sections for Fe, Ni, Sn, Ta, Pt, Au, Pb, U. Kerr Del Grande, N. (Lawrence Livermore National Lab., CA (USA)). Jun 1986. Contract W-7405-ENG-48. 10p. (CONF-860880—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012355.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

Total absolute photoabsorption cross sections were measured at 1 keV to 40 keV for Fe, Ni, Sn, Ta, Pt, Au, Pb and U. Overall measurement uncertainties were 3%, less than 2% of which were statistical. The measurements tested widely-used theoretical and experimental tables. They favored relativistic Hartree-Slater atomic calculations. Agreement with theory was typically 5% or better, except near the absorption edge energy region with EXAFS peaks. The measured peak and valley magnitudes for the solid samples ranged from 0% to 20% (with an average of 10%) above the atomic calculations for Fe and Ni. Discrepancies with experimental tables, at energies below 6 keV, were 10% to 40%. Authors of widely-used tables have been fraught with problems where there were few or no prior measurements, only interpolations and theory. The present measurements used samples from a few hundred to a few thousand $\mu g/cm^2$, such that the mean free path thicknesses, μrho x, were 1 and 3 at 1.5 keV. Samples were vapor-deposited on, and floated off of, optically flat glass slides. Their weights per unit area, rho x g/cm^2, were determined within 2% or 3%. Thicker samples, of known weights per unit area, were used for the higher energy measurements. The ratio of μrho x for thick and thin samples tested rho x for the thin samples. Back-scattered protons and alpha particles, as well as ion microanalyses, were used to test the samples' purity. Uranium deposits were sandwiched between two beryllium layers to impede surface oxidation. The transmission measurements were taken with a demountable x-ray tube, vacuum crystal monochromator and flow proportional counter, using slits that provided a narrow-beam geometry. 19 refs., 5 figs.

39077 Measurement of the rotational spectrum of the water cation (H_3O^+) by laser magnetic resonance. (Department of Chemistry and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Journal of Chemical Physics;* 85: No. 3, 1252-1260(1 Aug 1986).

Nine rotational transitions of v-italic = 0 X-italic-tilde ^{2}B-italic$_1$ H_3O^+ have been measured by laser magnetic resonance. Optical combination differences have been combined with the LMR data in a weighted-least-squares analysis using a Watson S-italic-reduced rotational-fine structure Hamiltonian. Twenty-four molecular constants were simultaneously determined, including three hyperfine parameters and the axial components of both the anisotropic and rotational g-italic tensors. The anisotropic g-italic tensors are compared with their calculated values using the Curl relationship. An r-italic$_0$ structure was determined and is in good agreement with several a-italicb-italic i-italicn-italici-italict-italici-italico-italic results.

39078 Studies of total ionization in gases/mixtures of interest to pulsed power applications. Reinking, G.F.; Christophorou, L.G.; Hunter, S.R. (Atomic, Molecular and High Voltage Physics Group, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Applied Physics;* 60: No. 2, 499-508(15 Jul 1986). Contract AC05-84OR21400.

The energy required to produce an electron-ion pair (i.p.), W, for the α-particle irradiated gases CF_4, C_2F_6, C_3F_8, and n-C_4F_{10} has been measured and found to be 34.3, 34.5, 34.4, and 34.2 eV/i.p., respectively. The large values of W for these perfluorocarbons (PFCs) are attributed to their large cross sections for electron impact-induced dissociation. The constancy of W for this group of molecules is discussed with respect to the constancy of the ratio ($\sim$0.68) of the respective (energy integrated) total ionization cross section to the total (energy integrated) inelastic scattering cross section. W values are also reported for the binary gas mixtures Ar/CF_4, Ar/C_2F_6, Ar/C_3F_8, and CH_4/CF_4 which have conduction and insulation properties suitable for use in diffuse discharge opening switches. The W values for these binary mixtures (and for C_2H_2/CF_4, C_2H_2/C_2F_6, and C_2H_2/C_3F_8) increase with the amount of PFCs in the mixture and (contrary to the Ar/C_2H_2 mixture) exhibit no Jesse effect. The ternary gas mixtures Ar/C_2H_2/PFC (= CF_4, C_2F_6, C_3F_8) containing $<$ or $\approx$10% PFC were found to exhibit a pronounced Jesse effect which is a function of the content of the PFC in the mixture and the electron scattering cross section of the PFC itself. Substantial increases in ionization can be achieved by adding to the Ar/PFC binaries 1-3% of C_2H_2.

39079 Sputtering of negative hydrogen ions by cesium bombardment. Lopes, J.L.; Greer, J.A.; Seidl, M. (Department of Physics and Engineering Physics, Stevens Institute of Technology, Hoboken, New Jersey 07030). *Journal of Applied Physics;* 60: No. 1, 17-23(1 Jul 1986). Contract AC02-84ER53167.

The production of negative hydrogen ions sputtered from a low work function converter surface has been investigated. Hydrogen and cesium admitted into the vacuum chamber are chemisorbed on a polycrystalline molybdenum target. H^-, Mo^-, and e^- are sputtered from this cathode by Cs^+ ions in the energy range 150—1000 eV. Angular and parallel energy distributions of H^-, Mo^-, and e^- are measured as a function of hydrogen gas pressure, cesium coverage, and incident ion energy. For optimum coverage, the H^- ion temperature varies from 0.65% and 0.35% of the incident Cs^+ bombarding energy for Cs^+ ion energies of 250 and 1000 eV, respectively. The secondary electrons have a temperature of 0.04% of the bombarding energy almost independent of Cs^+ energy. The spreads increase with decreasing target coverage and are independent of surface roughness. The optimum H^-, Mo^-, and e^- yields are also measured as a function of hydrogen pressure and incident Cs^+ bombarding energy. The optimum H^- ion yield is 0.41 at a Cs^+ ion energy of 750 eV. By extrapolating the H^- ion yield at low Cs^+ bombarding energy, a Cs^+ ion threshold energy of 120 eV may be estimated. This indicates a binding energy of hydrogen smaller than 3.6 eV.

39080 Electron transport measurements in methane using an improved pulsed Townsend technique. Hunter, S.R.; Carter, J.G.; Christophorou, L.G. (Atomic, Molecular and High Voltage Physics Group, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Applied Physics;* **60**: No. 1, 24-35(1 Jul 1986). Contract AC05-84OR21400.

An improved pulsed Townsend technique for the measurement of electron transport parameters in gases is described. The accuracy and sensitivity of the technique have been investigated by performing, respectively, electron attachment coefficient measurements in pure O_2 over a wide range of E/N at selected O_2 pressures and by determining the electron attachment and ionization coefficients and electron drift velocity in CH_4 over a wide E/N range. Good agreement has been obtained between the present and the previously published electron attachment coefficients in O_2 and for the drift velocity measurements in CH_4. The data on the electron attachment coefficient in CH_4 (measured for the first time) showed that with the present improved pulsed Townsend method, electron attachment coefficients up to 10 times smaller than the ionization coefficients at a given E/N value can be accurately measured. Our measurements of the electron attachment and ionization coefficients in CH_4 are in good agreement with a Boltzmann equation analysis of the electron gain and loss processes in CH_4 using published electron scattering cross sections for this molecule.

39081 Gerade electronic states of Xe_2 observed using resonantly enhanced multiphoton ionization. Dehmer, P.M.; Pratt, S.T.; Dehmer, J.L. (Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Chemical Physics;* **85**: No. 1, 13-24(1 Jul 1986). Contract W-31-109-ENG-38.

The two photon resonant, three photon ionization spectrum of the rare gas dimer Xe_2 was determined in the energy region of the Xe* 5d and 6p states. A number of new band systems were observed that arise from two photon transitions from the ground state to bound vibrational levels of excited states of gerade symmetry. The analysis of the observed vibronic structure of these band systems provides new information on the dissociation energies and the potential energy curves of the low-lying dipole forbidden excited states of Xe_2.

39082 Vibrational effects in the spin-orbit autoionization of HBr. Lefebvre-Brion, H.; Dehmer, P.M.; Chupka, W.A. (Laboratoire de Photophysique Moleculaire, Bat. 213, Universite de Paris-Sud, 91405 Orsay, France). *Journal of Chemical Physics;* **85**: No. 1, 45-50(1 Jul 1986). Contract W-31-109-ENG-38.

The high resolution relative photoionization cross section for HBr is reported in the energy region between the $^3Pi_3$/sub //$_2$ and $^3Pi_1$/sub //$_2$ ionic limits. A theoretical interpretation of the spectrum is given using the multichannel quantum defect theory with an ab initio calculation of the relevant electronic quantities. The vibrational couplings due to the R variation of both the electrostatic and the spin-orbit matrix elements are introduced and are shown to be essential to reproduce the qualitative features of the experimental data in the 1052—1060 A wavelength region.

39083 Observation of rapid E-to-V energy transfer in the 2.3 μm laser-induced fluorescence of PuF_6 containing HF. Rice, W.W.; Barefield, J.E. II; Pack, R.T. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Chemical Physics;* **85**: No. 1, 255-261(1 Jul 1986).

Following excitation of PuF_6 at 800 nm, laser-induced fluorescence (LIF) of PuF_6 is observed near 2.3 μm; HF v = 1 to 0 emission, arising from near resonant electronic-to-vibrational (E→V) energy transfer, is also observed with the same temporal decay as the PuF_6 fluorescence. From the rise and decay times of the PuF_6 and HF fluorescence and their relative intensities, all the rate constants involved in this relaxation are determined. The E→V rate constant is found to be (7.5 +- 2.5) x 10^3 $Torr^{-1}$ s^{-1}, and that for the relaxation of HF (v = 1) by PuF_6 is found to be (5.7 +- 0.7) x 10^3 $Torr^{-1}$ s^{-1}.

39084 Infrared energy levels and intensities of carbon dioxide Part 3. (U.S. Air Force Geophysics Laboratory, Optical Physics Division, Hanscom Air Force Base, Massachusetts 01731). *Applied Optics;* **25**: No. 11, 1795-1816(1 Jun 1986).

New spectroscopic constants have been calculated for seven isotopic variants of carbon dioxide. Extensive new high resolution observations provide access to the majority of the vibrational energy levels for $^{12}C^{16}O_2$ and $^{13}C^{16}O_2$ below 7000 cm^{-1} and for $^{13}C^{16}O^{18}O$ below —5000 cm^{-1}. Recent intensity measurements provided by Fourier transform spectroscopy have been incorporated with parallel band intensity calculations to furnish improved band intensities for a significant number of carbon dioxide bands. An updated list of 634 bands which play a role in terrestrial atmospheric transmission and emission problems is given. The constants provided in this paper are also of use in preliminary analysis for identifying transitions observed for the first time or measured to higher rovibrational levels.

39085 Experimental studies of three-photon ionization of Ba: Evidence of channel interference and Raman coupling. Kelly, J.F.; Hessler, J.P.; Alber, G. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review [Section] A: General Physics;* **33**: No. 6, 3913-3937(Jun 1986). Contract W-31-109-ENG-38.

Three-photon ionization spectra of Ba were studied which result from two-photon resonances between the $6s^2$ $^1S_0$ ground state and the 6snd J = 2,6s(n + 1)s $^1S_0$ (16< or =n<40) Rydberg states and 5d7d $^1D_2$, ^3P/sub 0,2/ perturber states. A tunable laser with field strength 10^-/sup($^{+5}$) a.u. was used to drive the excitation in a low-density atomic beam (n< or ≈3 x 10^9 cm^{-3}). Resonant line shapes were systematically studied as a function of light polarization and intensity. Studies with linearly polarized light find all resonant line shapes manifest the same peak shift and asymmetry which is traced to the ac Stark shift of the ground state. The resonant peak height, shift, and linewidth scale linearly with light intensity which is accounted for with a rate-equation formulation.

39086 Electron-impact ionization of Mg-like ions: S^{4+}, Cl^{5+}, and Ar^{6+}. Howald, A.M.; Gregory, D.C.; Meyer, F.W.; Phaneuf, R.A.; Mueller, A.; Djuric, N.; Dunn, G.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] A: General Physics;* **33**: No. 6, 3779-3786(Jun 1986). Contract AC05-84OR21400.

Absolute electron-impact ionization cross sections were measured as a function of collision energy for ions in the Mg-isoelectronic sequence S^{4+}, Cl^{5+}, and Ar^{6+}. The measurements cover the energy range from threshold to 1500 eV and show onsets due to the indirect ionization process of inner-shell excitation followed by autoionization. The relative magnitude of the indirect ionization process increases dramatically in comparison with the direct process along the sequence, a feature which is also emphasized by earlier data for Al^+.

39087 Electron-impact ionization in the magnesium-isoelectronic sequence. Pindzola, M.S.; Griffin, D.C.; Bottcher, C. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] A: General Physics;* **33**: No. 6, 3787-3791(Jun 1986). Contract AC05-84OR21400.

Excitation-autoionization contributions to the electron-impact ionization of the Mg-like ions S^{4+}, Cl^{5+}, and Ar^{6+} are calculated in the distorted-wave approximation. The calculations indicate that the largest contributions are due to the 2p→3p monopole and 2p→3d dipole excitations from either the $2p^63s^2$ ground-state configuration or the $2p^63s3p$ excited-state configuration. Excellent agreement with the experimental crossed-beam measurements of Howald et al. is obtained when one assumes that a substantial fraction of the ions coming from the electron cyclotron resonance ion source are in metastable states of the $2p^63s3p$ excited-state configuration.

39088 Resonant charge transfer in symmetric alkali-ion—alkali-atom collisions. Men, F.K.; Kimura, M.; Olson, R.E. (Department of Physics, University of WisconsinMadison, Madison, Wisconsin 53706). *Physical Review [Section] A: General Physics;* 33: No. 6, 3800-3806(Jun 1986).

Resonant charge transfer in alkali-ion—alkali-atom collisions is investigated by using the molecular-orbital expansion method incorporating the use of electron translation factors. Molecular wave functions and eigenenergies are obtained by the pseudopotential method. Molecular properties, R/sub e/, D/sub e/, and ω/sub e/, obtained in the present calculation are in good accord with other recent theoretical results, as well as spectroscopic measurements. Three-state close-coupling calculations reproduce the positions of the maxima and minima in the oscillatory structure seen experimentally in the resonant-charge-transfer cross sections for the Li_2^+ and Cs_2^+ systems. The magnitude of the total cross sections and their velocity dependence are in agreement with experimental measurements.

39089 Contributions of excitation autoionization to electron-impact ionization of Mg-like Al^+, S^{4+}, Cl^{5+}, and Ar^{6+} ions. Tayal, S.S.; Henry, R.J.W. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803-4001). *Physical Review [Section] A: General Physics;* 33: No. 6, 3825-3831(Jun 1986).

The R-matrix method is used to calculate the contributions of excitation autoionization to electron-impact ionization in Mg-like Al^+, S^{4+}, Cl^{5+}, and Ar^{6+} ions. The ground $3s^2\ ^1S$ state together with the autoionizing states arising from the $2p^63s^23p$, $2p^63s^23d$, $2p^63s^24s$, $2s2p^63s^23p$, $2s2p^63s^23d$, and $2s2p^63s^24s$ configurations are included in the R-matrix expansion. Large numbers of bound terms of appropriate symmetry are included in the expansion to account for the resonant-excitation—double-autoionization process. The total ionization cross sections are obtained by combining the cross sections for inner-shell excitation with direct-ionization cross sections. Our calculation shows an abrupt and significant rise in the cross sections, in agreement with recent crossed-beam measurements of Howald et al. The importance of indirect processes over the direct process increases with increasing ionic charge along the sequence.

39090 Spectrum of sodium-like selenium: Se XXIV. Brown, C.M.; Seely, J.F.; Feldman, U.; Richardson, M.C.; Behring, W.E.; Cohen, L. (EO Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375-5000). *Journal of the Optical Society of America B: Optical Physics;* 3: No. 5, 701-703(May 1986). Contract AI08-79DP40092;FC08-85DP40200.

High-resolution spectra of Se XXIV have been obtained with a 3-m gazing-incidence spectrograph. Thin plastic foils coated with selenium were irradiated with four or eight beams of the OMEGA laser in a line-focus configuration. Spectrograms were obtained by viewing the plasma axially. Prominent in the spectra were the 3s-3p and 3p-3d transitions in the 150-2400-A region and the transitions nl-(n+1)l with n = 3,4 in the 24-80-A region. We also present the energy levels and ionization limit derived from the measured wavelengths.

39091 State-selective ionization detection of neutral NO following electron-stimulated desorption. Burns, A.R. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1499-1500(May 1986). Contract AC04-76DP00789.

A tunable UV laser is used to selectively ionize neutral NO molecules that are in specific rotational and vibrational states following electron-stimulated desorption (ESD) from NO-covered Ni and Pt surfaces. An analysis of the results supports previous studies that reported a shallow valence-level mechanism for ESD neutrals.

39092 Auger and electron energy loss study of the electronic structure of U—M(M = Fe,Co,Ni) metallic glasses. Bevolo, A.J.; Drehman, A.J. (Ames Laboratory, Energy and Mineral Resources Research Institute, Iowa State University, Ames, Iowa 50011). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1589-1594(May 1986).

Auger intensity measurements from a series of U/sub 100-x/M/sub x/(M = Fe,Co,Ni) metallic glasses confirms a predicted change in local order about the uranium atoms for alloy compositions near $U_{72}M_{28}$. As x increases, independent of M, more electrons are charge transferred out of the uranium local density of valence states (LDOVS). At the highest x value measured, $U_{42}Co_{58}$, more than half of the valence electrons in the uranium LDOVS have been lost. The 5d core level electron energy loss spectra suggest that for x< or =28,6d valence states are involved in the charge transfer, while for x> or =28, it is mostly the 5f states that are involved.

39093 Ionic and neutral decomposition of gaseous bromochloromethanes. Driscoll, D.C.; Bishop, J.A.; Sturm, B.J.; Dowben, P.A.; Olsen, C.G. (Department of Physics and the Laboratory for Solid State Science and Technology, Syracuse University, Syracuse, New York 13244). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 823-827(May 1986). Contract W-7405-ENG-82.

The ionization potentials for CCl_4, CCl_3Br, CBr_2Cl_2, CBr_4, CCl_3, and CBr_3 have been measured using electron impact techniques. These numbers have been combined with previously published thermodynamic values in order to construct thermodynamic cycles for ionic and neutral decomposition of the bromochloromethanes. The n to σ^*, n to s, and n to p electronic transition energies have also been determined on the basis of photoabsorption spectra.

39094 Detection of surface glow related to spacecraft glow phenomena. Langer, W.D.; Cohen, S.A.; Manos, D.M.; Motley, R.W.; Ono, M.; Paul, S.F.; Roberts, D.; Selberg, H. (Plasma Physics Laboratory, Princeton University, P.O. Box 451, Princeton, NJ 08544). *Geophysical Research Letters;* 13: No. 4, 377-381(Apr 1986).

A source of low energy neutral atoms and molecules was developed by using a biased limiter to scrape-off and reflect neutralized ions from a toroidal plasma. Beams of nitrogen and nitrogen-oxygen mixtures with energies of 1 to 15 eV and fluxes > 10^{14}/cm^2/s were directed on target surfaces consisting of z-302 and z-306 paints. With the nitrogen beams a glow due to beam-surface interactions were detected. In addition, a volume glow effect due to beam-gas interactions which may play a role in spacecraft glow was observed.

39095 Status of the AGS polarized negative ion source. Sluyters, T.; Alessi, J.; Kponou, A. (Accelerator Department, Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York 11973). *AIP (American Institute of Physics) Conference Proceedings;* 117: No. 1, 25-31(25 May 1984). (CONF-830591—).

From Polarized ion workshop; Vancouver, Canada (23 May 1983).

A polarized negative ion source (H) has been modified for use in the A Anating Gradient Synchrotron to produce once every second a beam of 7.5 mic roamperes in .5 ms pulses. The source was based on the co-linear colliding principle whereby a polarized thermal atomic hydrogen beam collides in the interaction (solenoid) region with 40 keV neutral cesium particles, producing the negative hydrogen ions by charge exchange processes.

39096 Ring magnetron ionizer for polarized negative ion sources. Alessi, J.G.; Sluyters, T.; Hershcovitch, A. (Accelerator Department, Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York 11973). *AIP (American Institute of Physics) Conference Proceedings;* 117: No. 1, 32-36(25 May 1984). (CONF-830591—).

From Polarized ion workshop; Vancouver, Canada (23 May 1983).

A method is proposed for producing a polarized negative ion source coning of hydrogen 1 minus ions. This simple method uses a self-extracted deuterium 1 minus ion beam from a ring magnetron source to produce a polarized negative hydrogen ion beam by charge exchange reactions. This method not only offers improvements in intensity, but equally important, improvements in reliability and lifetime.

39097 **Developing a 500 eV proton beam.** Chamberlin, E.P.; Benage, J.F. Jr.; Williams, H.E. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *AIP (American Institute of Physics) Conference Proceedings;* **117**: No. 1, 82-93(25 May 1984). (CONF-830591—).

From Polarized ion workshop; Vancouver, Canada (23 May 1983).

Tests have been carried out which indicate that H^- intensity limitations in Lamb-shift polarized ion sources result from large divergence in the 500 eV H^+ ion beam. Intensity limitations due to other effects are not yet measurable.

39098 **Working group summary-lamb-shift sources.** Clegg, T.B. (Department of Physics, University of North Carolina, Chapel Hill, North Carolina 27514). *AIP (American Institute of Physics) Conference Proceedings;* **117**: No. 1, 103-113(25 May 1984). (CONF-830591—).

From Polarized ion workshop; Vancouver, Canada (23 May 1983).

Basic charge-exchange cross sections on which the Lamb-shift source relies are reviewed. In addition the various processes which cause destruction of the 2S-metastable atoms inside the source are examined. Understanding these processes is certainly important for optimizing the intensity and polarization of the emerging beam. Measurements which can be used to learn about the beam plasma of ions and electrons in the source and the contribution of this plasma in quenching the matastable atoms are discussed.

39099 **Charge-transfer collisions for polarized ion sources.** Schlachter, A.S. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *AIP (American Institute of Physics) Conference Proceedings;* **117**: No. 1, 180-205(25 May 1984). (CONF-830591—). Contract AC03-76SF00098.

From Polarized ion workshop; Vancouver, Canada (23 May 1983).

Charge-transfer processes relevant to polarized ion sources are discussed and results are summarized. The primary atom discussed is hydrogen, with particular emphasis on H^- formation. Heavier negative ions are briefly discussed.

39100 **Spin exchange optical pumping to produce large amounts of polarized nuclei.** Happer, W.; Miron, E.; Knize, R.; Cecchi, J. (Princeton University, Princeton, New Jersey 08544). *AIP (American Institute of Physics) Conference Proceedings;* **117**: No. 1, 114-122(25 May 1984). (CONF-830591—). Contract AC02-76CH03073.

From Polarized ion workshop; Vancouver, Canada (23 May 1983).

The transfer of momentum by spin exchange collisions are discussed for an alkali vapor, which can be easily polarized by optical pumping. For hydrogen atoms the spin exchange rates can be very fast and the alkali vapor can be only a small trace contamination of the atomic hydrogen gas.

39101 **Vibrational energy distribution of CO in the oxidation of C on Pt.** Kori, M.; Halpern, B.L. (Yale Univ., New Haven, CT). *Chemical Physics Letters;* **98**: No. 1, 32-36(10 Jun 1983). Contract FG01-78ET11384.

CO, excited to its seventh vibrational level, is generated by C oxidation on Pt at 1000-1400 K. Analysis of its Fourier transform IR emission spectrum suggests a non-equilibrium, yet statistical, vibrational distribution. A long-lived reaction complex involving 2-3 Pt atoms is postulated. 20 references, 2 figures.

39102 **Inner shells as a link between atomic and nuclear physics.** Merzbacher, E. (Univ. of North Carolina, Chapel Hill). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 1-12(1982). (CONF-820855—). Contract AS05-76ER02408.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

Nuclear decay and reaction processes generally take place in neutral or partially ionized atoms. The effects of static nuclear properties (size, shape, moments) on atomic spectra are well known, as are electronic transitions accompanying nuclear transitions, e.g. K capture and internal conversion. Excitation or ionization of initially filled inner shells, really or virtually, may modify nuclear Q values, will require correction to measured beta-decay endpoint energies, and can permit the use of inner-shell transitions in the determination of nuclear widths. Improvements in resolution continue to enhance the importance of these effects. There is also beginning to appear experimental evidence of the dynamical effects of atomic electrons on the course of nuclear reactions. The dynamics of a nuclear reaction, which influences and may in turn be influenced by atomic electrons in inner shells, offers instructive examples of the interplay between strong and electromagnetic interactions and raises interesting questions about coherence properties of particle beams. A variety of significantly different collision regimes, depending on the atomic numbers of the collision partners and the collision velocity, will be discussed and illustrated. 21 References, 5 figures.

39103 **Atomic inner-shell threshold excitation with synchrotron radiation.** Ice, G.E.; Brown, G.S.; Armen, G.B.; Chen, M.H.; Crasemann, B.; Levin, J.; Mitchell, D. (Oak Ridge National Lab., TN). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 105-113(1982). (CONF-820855—). Contract W-7405-ENG-26.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

Monochromatized synchrotron radiation from a focused 8-pole wiggler beam line has been used to excite the L_3 and L_2 holes of atomic Xe and the K hole of atomic Ar near their photoionization thresholds. The Xe L_3-M_4M_5 ($^1G_4$) Auger line, the Xe L_2-L_3N_{45} Coster-Kronig line, and the Ar K-$L_{23}L_{23}$ Auger line with incident x-ray energies from ~20 eV below threshold to ~200 eV above threshold have been measured. The spectra allow accurate determination of spectator-satellite energy shifts, post-collision interaction (PCI) shifts in the diagram-line energy, and spectral changes associated with the resonant Raman Auger (RRA) effect. The energies of satellites corresponding to photoelectrons promoted to bound states exhibit linear dispersion as a function of the initial photon energy. The measured post-collision interaction energy shifts of the diagram lines agree qualitatively with semiclassical PCI theory above threshold. In all cases, the energy of the diagram line is observed to decrease below threshold. The intensity of the 5d spectator line associated with the Xe L_3-M_4M_5 line is larger than expected from absorption measurements. 7 references, 7 figures.

39104 **Resonant behavior in the projectile K x-ray yield associated with electron capture in ion-atom collisions.** Tanis, J.A.; Bernstein, E.M.; Graham, W.G.; Clark, M.; Shafroth, S.M.; Johnson, B.M.; Jones, K.; Meron, M. (Western Michigan Univ., Kalamazoo). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 146-157(1982). (CONF-820855—). Contract AC02-76CH00016.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

A review of recent effects to observe simultaneous electron capture-and-K-shell excitation in ion-atom collisions is presented. This process is qualitatively analogous to dielectronic recombination (inverse Auger transition) in free-electron-ion collisions, and, hence, is expected to be resonant. Experimentally, events having the correct signature for simultaneous capture-and-excitation are isolated by detecting projectile K x rays in coincidence with ions which capture a single electron. In a recent experiment involving 70-160 MeV S^{15+} ions incident on Ar, resonant behavior was observed in the yield of projectile K x rays associated with electron capture. This resonance is attributed to simultaneous capture-and-excitation. The position (120 MeV) and width (60 MeV) of the ob-

served resonance are in good agreement with theoretical calculations. The data indicate that this resonant process is an important mechanism in inner-shell vacancy production in the energy range studied. 11 references, 4 figures, 1 table.

39105 In search of spontaneous positron creation. Greenberg, J.S. (Yale Univ., New Haven, CT). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 173-205(1982). (CONF-820855—). Contract AC02-76ER03074.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

The recent experiments investigating the behavior of the electron-positron field in strong external electromagnetic fields is reviewed. In particular, the search for spontaneous positron creation in superheavy collision systems is discussed. A striking new result emerging from this search is the observation of narrow peaked structures in the positron spectra whose origin cannot be associated with the established dynamic mechanisms of positron production involving Coulomb trajectories only. The possibility that these peaks may be signatures for the spontaneous decay of the vacuum and for the formation of metastable giant nuclear complexes is considered in the content of recent experimental results. 52 references, 23 figures.

39106 Collisionally excited few-electron systems: theoretical introduction and survey. Ford, A.L.; Reading, J.F.; Becker, R.L. (Texas A & M Univ., College Station). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 229-241(1982). (CONF-820855—). Contract W-7405-ENG-26.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

Excitation, ionization, and charge transfer in collisions of protons (and antiprotons) with the single-electron targets H, He^+, and Li^{2+} are considered. These collisions are fist compared to other types of ion-atom collisions. A brief review of the authors' theoretical method is given; in particular a description is given of how the authors allow for both large charge transfer and ionization probabilities while retaining the computational efficiency that allows them to consider a variety of collision partners and collision energies. The comparison of the results to other theoretical work and to experiment is commented on. The qualitative features of the various inelastic cross sections are discussed, in particular how they scale with collision energy, target nuclear charge, and the sign of the projectile charge. 15 references, 6 figures.

39107 Production of collisionally excited few-electron ions. Cocke, C.L. (Kansas State Univ., Manhattan). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 242-252(1982). (CONF-820855—).

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

This paper reviews some characteristics of the production of slow, highly ionized recoils in the bombardment of gaseous targets by fast heavy ion beams. One example of the use of an ion source based on this idea is discussed. 29 references, 15 figures.

39108 Wigglers and undulators as intense x-ray sources. Brown, G.S. (Stanford Synchrotron Radiation Lab., CA). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 318-320(1982). (CONF-820855—).

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

It is now evident, from both theoretical and operational experience, that the synchrotron radiation emitted by special purpose insertion devices (wigglers and undulators), is several orders of magnitude more intense than the radiation from conventional bending magnets. The radiation is highly polarized, and, in the case of undulators, quasi-monochromatic and highly polarized. These properties have motivated the construction of such devices on a number of electron storage rings, many of which have now fully instrumented beam lines. In what follows, the spectral properties of the radiation emitted by such devices are discussed , and the facilities that are available for atomic physics research are summarized. 2 references, 1 table.

39109 Many-electron effects in photoelectron core spectra. Lindau, I. (Stanford Univ., CA). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 559-568(1982). (CONF-820855—).

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

Many electron effects in photoelectron core spectra are now well-established phenomena. This paper will be centered around experiments where the tunability of synchrotron radiation has been utilized to study: 1. Photoelectron emission enhancement of the 5s and 5p partial photoionization crossections at and above the photoionization threshold for the 4d subshell of Ba. These many-electron effects can be studied as the photon energy is continuously tuned through the ionization thresholds of inner core levels; 2. The plasmon loss intensity as a function of the excitation energy of the photons for a few free-electron like elements (Al, Si). A strong enhancement is observed in the 5s and 5p partial crossections at and above the 4d ionization threshold in Ba. These resonances cannot be described in the framework of a one-electron model but are strong many-body effects. However, the more advanced many-body calculations can reproduce the 4d excitation as well as the enhancement in the outer 5s and 5p shells quite accurately. The intensity of the bulk plasmon loss structure was studied over a broad photon energy range from core levels of Si and Al. A clear trend is observed when the excitation energy is tuned from the ionization threshold and up. 50 references, 5 figures.

39110 Resonance and threshold effects in photoemission up to 3500 eV. Shirley, D.A.; Kobrin, P.H.; Lindle, D.W.; Truesdale, C.M.; Southworth, S.H.; Becker, U.; Kerkhoff, H.G. (Lawrence Berkeley Lab., CA). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 569-583(1982). (CONF-820855—). Contract AC03-76SF00098.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

Beam Lines at the Stanford Synchrotron Radiation Laboratory (SSRL) now provide photon beams throughout the entire range 5-5000 eV, with a pulse structure very well-suited to time-of-flight (TOF) photoelectron spectroscopy. This facility, together with a TOF spectrometer, has been used to measure photo-emission cross sections $\sigma(\epsilon)$ and asymmetry parameters $\beta(\epsilon)$ for several interesting systems. A summary of early results is given. Metal vapors (Ba, Cd, Mn, Hg) were studied using a high-temperature oven. Resonant photoemission was observed in several cases. Both $\sigma(\epsilon)$ and $\sigma(\epsilon)$ showed resonant behavior at 21.1 eV for several lines in Cd. The 4d, 5s, and 5p $\sigma(\epsilon)$ line profiles differed dramatically, illustrating the detailed information about continuum states that is available from photoemission. Correlation satellites in photoemission from rare gases have been observed over a very wide energy range, including those seen in the K-shells of He, Ne and Ar and in the L-shell of Ne. The structure and preliminary intensity variations of these satellites will be discussed. Molecular shape resonances in C(ls), N(ls), and O(ls) photoemission were observed for the first time, in the molecules CO, CO_2, OCS, CF_4, N_2 and NO. Both the π and σ resonances were observed in KVV Auger emission, and the σ resonances were studied by photoemission. 31 references, 18 figures.

39111 Exciting oxidation of CO on Pt. Mantell, D.A.; Ryali, S.B.; Halpern, B.L.; Haller, G.L.; Fenn, J.B. (Yale Univ., New Haven, CT). *Chemical Physics Letters;* **81:** No. 2, 185-187(15 Jul 1981). Contract FG01-78ET11384.

An uncollimated molecular beam (free jet) of CO and O_2 molecules incident on a polycrystalline Pt surface at 775 K in vacuo produces vibrationally hot CO_2 molecules at a density sufficient for infrared emission spectrometry. Analysis of spectra at a resolution of 0.1 cm^{-1} clearly shows that nascent product molecules have much more internal excitation than would be the case for equilibrium at the surface temperature. 4 references, 1 figure.

6404 Fluid Physics

REFER ALSO TO CITATION(S) 39071

39112 (AD-A—166015/8/XAB) Steady-state approach to excitation mechanisms in the ICP (inductively-coupled plasma). Technical report. Hieftje, G.M.; Rayson, G.D.; Olesik, J.W. (Indiana Univ., Bloomington (USA). Dept. of Chemistry). 1985. 14p. (INDU/DC/GMH/TR—85-68). NTIS, PC A02/MF A01.

A new approach to investigating ionization and excitation mechanisms within the inductively-coupled plasma (ICP) is described. The method involves a comparison of the spatial behavior of analyte emission intensities with the concentration product of reacting species as predicted by an assumed kinetically controlling mechanism. The limitations and uncertainties in this approach to mechanistic understanding are evaluated. In this preliminary study, the involvement of Penning and electron-impact processes resulting in ionization and excitation of calcium atoms and ions was investigated, and the resulting correlations are described. From these correlations, atom-excitation seems to occur through an ion-electron recombination process whereas ion generation and excitation is suggested to occur by a Penning process in the outer plasma regions and excitation by electron impact within the central channel of the ICP.

39113 (LA-UR—86-1679) Quantized vortex filaments in incompressible fluids. Goldin, G.A.; Menikoff, R.; Sharp, D.H. (Rutgers--the State Univ., New Brunswick, NJ (USA). Dept. of Mathematics; Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 4p. (CONF-8605145—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011249.

From International conference on the physics of phase space; College Park, MD, USA (20 May 1986).

Among the solutions A/sub t/(x) to the Euler equations for a classical incompressible fluid are those describing vortex filaments. Here we discuss quantum analogues of such solutions in 2 and 3 dimensions.

39114 Acceleration of a buoyant sphere in dry water. Crawford, F.S. (Virginia Institute for Theoretical Astronomy and Astronomy Department, University of Virginia). *American Journal of Physics;* **54**: No. 7, 584-584(Jul 1986).

It is pointed out that the formula for the upward acceleration of a submerged, buoyant sphere should contain the effective mass of the water that is accelerated downward. (AIP)

39115 Some rigorous results concerning spectral theory for ideal MHD. Laurence, P. (Department of Mathematics, Pennsylvania State University, University Park, Pennsylvania 16802). *Journal of Mathematical Physics (New York);* **27**: No. 7, 1916-1926(Jul 1986). Contract AC02-76ER03077.

Spectral theory for linear ideal MHD is laid on a firm foundation by defining appropriate function spaces for the operators associated with both the first- and second-order (in time and space) partial differential operators. Thus, it is rigorously established that a self-adjoint extension of F(ξ) exists. It is shown that the operator L associated with the first-order formulation satisfies the conditions of the Hille—Yosida theorem. A foundation is laid thereby within which the domains associated with the first- and second-order formulations can be compared. This allows future work in a rigorous setting that will clarify the differences (in the two formulations) between the structure of the generalized eigenspaces corresponding to the marginal point of the spectrum $\omega = 0$.

39116 Explosion of water droplets. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Applied Optics;* **25**: No. 11, 1837-1839(1 Jun 1986).

We use self-similarity to describe the motion of vapor emanating from a water droplet that has been exploded by a short pulse from a high energy laser. This approach allows us to obtain a qualitative description of the experiment of Kafalas and Herrmann.

39117 Comment on "Classical hard-sphere fluid in infinitely many dimensions". Luban, M. (Department of Physics, 12 Physics Building, Iowa State University, Ames, Iowa 50011). *Physical Review Letters;* **56**: No. 21, 2330-2330(26 May 1986). Contract W-7405-ENG-82.

A Comment on the Letter by Frisch, Rivier, and Wyler, Phys. Rev. Lett. 54, 2061 (1985).

39118 Analytic theory of the selection mechanism in the Saffman-Taylor problem. Hong, D.C.; Langer, J.S. (Institute for Theoretical Physics, University of California, Santa Barbara, California 93106). *Physical Review Letters;* **56**: No. 19, 2032-2035(12 May 1986). Contract FG03-84ER45108.

We present an analytic approach to the problem of predicting the widths of fingers in a Hele-Shaw cell. Our analysis is based on the WKB technique developed recently for dealing with the effects of surface tension in the problem of dendritic solidification. We find that the relation between the dimensionless width λ and the dimensionless group of parameters containing the surface tension, ν, has the form λ-(1/2)~ν/sup 2/3/ in the limit of small ν.

39119 Shape selection of Saffman-Taylor fingers. Combescot, R.; Dombre, T.; Hakim, V.; Pomeau, Y.; Pumir, A. (Groupe de Physique des Solides, Ecole Normale Superieure, F-75231 Paris Cedex 05, France). *Physical Review Letters;* **56**: No. 19, 2036-2039(12 May 1986).

Among all problems of pattern selection the one posed by the Saffman-Taylor finger is yet unsolved, although numerics and experiments indicate the very simple property that the relative width of the finger tends to (1/2) in the low—surface-tension limit. We explain this by performing an expansion beyond all orders leading to the formulation of a nonlinear eigenvalue problem with a discrete set of solutions. In particular we predict that the relative width of the finger tends to (1/2) as the surface tension to the power (2/3).

39120 Spin relaxation in normal liquid ^{3}He: T-italic$_1$ in the Fermi liquid (T-italic<<T-italic/sub F/) regime. (Department of Physics, State University of New York at Stony Brook, Stony Brook, New York). *Journal of Low Temperature Physics;* **63**: No. 3, 215-234(1 May 1986).

The low-temperature (T-italic<<T-italic/sub F/) spin relaxation time T-italic$_1$ in normal liquid ^{3}He is calculated. First an expression for T-italic$_1$ is obtained using the Landau kinetic equation, which is in terms of the perturbations of the scattering amplitudes due to nuclear dipole-dipole interactions. These perturbations are obtained using the induced interaction model, which explicitly includes the effects of many-body correlations arising from the Pauli principle. The results are in good agreement with experiment, as well as with previous calculations.

39121 Prediction of flow rates through an orifice at pressures corresponding to the transition between molecular and isentropic flow. DeMuth, S.F.; Watson, J.S. (Fuel Recycle Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 344-347(May 1986). Contract AC05-84OR21400.

A model of compressible flow through an orifice, in the region of transition from free molecular to isentropic expansion flow, has been developed and tested for accuracy. The transitional or slip regime is defined as the conditions where molecular interactions are too many for free molecular flow modeling, yet not great enough for isentropic expansion flow modeling. Due to a lack of literature establishing a well-accepted model for predicting transitional flow, it was felt such work would be beneficial. The model is nonlinear and cannot be satisfactorily linearized for a linear regression analysis. Consequently, a computer routine was developed which minimized the sum of the squares of the residual flow for the nonlinear model. The results indicate an average accuracy within 15% of the measured flow throughout the range of test conditions. Furthermore, the results of the regression analysis indicate that the transitional regime lies between Knudsen numbers of approximately 2 and 45.

39122 Shearing motion of a fluid-saturated granular material. Passman, S.L.; Nunziato, J.W.; Bailey, P.B.; Reed, K.W. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Rheology;* 30: No. 1, 167-192(Feb 1986). Contract AC04-76DP00789.

We discuss the application of a recently developed theory of multiphase mixtures to fluid-saturated granular materials. The theory includes the incompressibility of each phase, but unlike other theories of the type, does not require pressure equilibrium between the phases. We do a theoretical study of the motion of this material in a viscometric simple shearing apparatus. It is shown that simple shearing generally does not occur. Typically, in the vicinity of a boundary, if the solid volume fraction is low, a layer of high shear rate occurs, while if the solid volume fraction is high, a "locking" phenomenon occurs. Otherwise, there is a tendency for particles to accumulate in regions of low shear rate.

39123 (ORNL/tr—86/22) Possible nonstationary solutions in the turbulence of a two-dimensional liquid. Krasheninnikov, S.I. (Oak Ridge National Lab., TN (USA); Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1986. Contract AC05-84OR21400. Translation of IAE-3960/6, Moscow, 1984. 6p. NTIS, PC A02/MF A01. File Number DE86012198.

It was found that a kinetic equation for the fluctuations in the velocity of an ideal two-dimensional incompressible liquid permits of self-similar solutions that preserve the energy and entropy. Estimates were obtained on the time-dependence of the intensity of the fluctuations. 10 refs.

39124 Method for computing three-dimensional turbulent flows. Bernard, P.S.; Berger, B.S. (Univ. of Maryland, College Park). *SIAM Journal on Applied Mathemadics;* 42: No. 3, 453-470(Jun 1982). Contract AS05-81ER10809.

The MVC (mean vorticity and covariance) turbulence closure is derived for three-dimensional turbulent flows. The derivation utilizes Lagrangian time expansion techniques applied to the unclosed terms of the mean vorticity and covariance equations. The closed mean vorticity equation is applied to the numerical solution of fully developed three-dimensional channel flow. Anisotropies in the wall region are modelled by pairs of counterrotating streamwise vortices. The numerical results are in close agreement with experimental data. Analysis of the contributions of the terms in the mean vorticity equation gives insight into the dynamics of the turbulent boundary. 41 references, 7 figures.

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REFER ALSO TO CITATION(S) 39206

39125 (BNL—37890) Hadronic production of J/sup PC/ = 2^{++} glueballs. Lindenbaum, S.J. (Brookhaven National Lab., Upton, NY (USA)). 17 Mar 1986. Contract AC02-76CH00016. 31p. (CONF-860150—5). NTIS, PC A03/MF A01; GPO Dep. File Number DE86011199.

From Winter condensed matter physics conference: frontiers in condensed matter X-ray physics; Aspen, CO, USA (12 Jan 1986).

An OZI suppressed channel with variable mass, namely the reaction $\pi^- p \rightarrow$ phi phi n, has been used as a filter which allows resonating gluons or glueballs to pass, while strongly rejecting conventional quark-built hadronic states. The breakdown of the OZI suppression signals a glueball. Glueball mass and particle width estimates are discussed. Reasons why g/sub T/'s have not been seen in other channels, particularly the decay of J/psi, are considered. 34 refs., 9 figs. (LEW)

39126 (DESY—85-115) B lifetime measurements from PETRA. Venkataramania, H. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Wisconsin Univ., Madison (USA). Dept. of Physics). Oct 1985. 31p. (CONF-850375—22; WIS—85/40/OCT-PH). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752065.

From 20. Recontre de Moriond; Les Arcs, France (10 Mar 1985).

Two detectors from PETRA, TASSO and JADE, have measured the B lifetime by first selecting a sample of b enriched events and then using the impact parameters of charged tracks in this sample. JADE does b enhancement using high psub(t) leptons while TASSO uses the higher sphericity of bottom jets compared to average jets. TASSO uses impact parameters of all 'good' tracks in an event while JADE uses only that of the lepton. TASSO and JADE measure the B lifetime to be 1.57 +- 0.32 +- 0.36 psec and 1.8 +- 0.5 +- 0.4 psec respectively. (orig./HSI).

39127 (DESY—85-119) Observation of a new charmed meson. Albrecht, H.; Binder, U.; Harder, G.; Lembke-Koppitz, I.; Philipp, A.; Schmidt-Parzefall, W.; Schroeder, H.; Schulz, H.D.; Wurth, R.; Donker, J.P. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Dortmund Univ. (Germany, F.R.). Inst. fuer Physik; Heidelberg Univ. (Germany, F.R.). Inst. fuer Hochenergiephysik; McGill Univ., Montreal, Quebec (Canada); Carleton Univ., Ottawa, Ontario (Canada); Toronto Univ., Ontario (Canada)). Nov 1985. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752069.

Using the ARGUS detector at DORIS II, we have obtained evidence for a new charmed resonance which decays into Dsup(*+-)(2010)πsup(-+). The observed mass and width are (2420 +- 6) MeV/c^2 and (70 +- 21) MeV/c^2 respectively. The fragmentation function is found to be hard, as expected for a state containing a leading charm quark produced by non-resonant e^+e^- annihilation. (orig.).

39128 (DOE/ER/03072—36) Pion structure as observed in Fermilab experiment E 615. McDonald, K.T. (Princeton Univ., NJ (USA)). 7 May 1986. Contract AC02-76ER03072. 7p. (CONF-8603119—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010434.

From 21. Rencontre de Moriond: strong interactions and gauge theories conference; Les Arcs, France (16 Mar 1986).

In an experiment performed at Fermilab we explore the structure of the pion via the Drell-Yan process, in the reactions π/sup +-/N $\rightarrow \mu^+\mu^-$X at 80 and 255 GeV/c. The emphasis is on the kinematic region in which the momentum of the pion is largely carried by a single quark, which proves to be rather accessible to experimental study. The data indicate substantial departures from the expectations of asymptotic QCD, but agree well with a calculation which includes the effect of gluon exchange among the quarks inside the pion. With our large sample of muon pairs, we also set the current-best limits on the decay $D^0 \rightarrow \mu^+\mu^-$ and on D^0-anti D^0 mixing.

39129 (DOE/ER/03230—T5) Research in elementary particle physics. Technical progress report, June 1, 1985-May 31, 1986. Kirsch, L.E.; Schnitzer, H.J.; Bensinger, J.R.; Abbott, L.F.; Blocker, C.A. (Brandeis Univ., Waltham, MA (USA). Dept. of Physics). 1986. Contract AC02-76ER03230. 26p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012491.

Progress is reported in both experimental and theoretical elementary particle research. Experimental activities include: construction of the Forward Electromagnetic Shower Counters for the Collider Detector at Fermilab (CDF); a test run in the CDF, involving observation of a small number of proton-antiproton collisions; design of a self-contained single wire proportional chamber with pressure and temperature sensing for monitoring the gain of gases used by various components of the CDF; data acquisition, and calibration. Also included are a search for a dibaryon of strangeness=-1; hyperon weak radiative decay. Theoretical research is reported in the areas of quantum field theory, string theory, elementary particle phenomenology, cosmology, field theory in curved spacetimes, and cosmology. 34 refs. (LEW)

39130 (DOE/ER/10663—T2) Experimental elementary particle physics research. Technical progress report. Arenton, M.W. (Arizona Research Labs., Tucson (USA)). Apr 1986. Contract AC02-80ER10663. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012205.

The major current activity reported, experiment E-705 at Fermilab, is discussed. This experiment was originally designed with two main physics objectives, the high-statistics study of charmonium production, and the study of high transverse momentum direct photons. Other work is reported that used the Fermilab Multiparticle Spectometer (MPS) to study final states containing multiple strange particles. One experiment, E-580, triggered on the materialization of two neutral Vee's plus up to 5 charged particles produced in 200 GeV/c pion minus-nucleon interactions. Another, E-623, triggered on 4 charged K's, with the addition of a trigger processor designed to enhance those events where the K's originated from phi decay, produced in 400 GeV/c pN interactions. Experiment E-609 was a study of the production of jets in 200 GeV/c pion-proton and 400 GeV/c proton-proton interactions using a large full-azimuth calorimeter detector. Analysis of single-jet and di-jet cross sections at 400 GeV/c are completed. (LEW)

39131 **(FNAL-TM—1400) View of software for HEP experiments.** Johnstad, H.; Lebrun, P.; Lessner, E.S.; Montgomery, H.E. (Fermi National Accelerator Lab., Batavia, IL (USA)). May 1986. Contract AC02-76CH03000. 36p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012596.

A view of the software structure typical of a High Energy Physics experiment is given and the availability of general software modules in most of the important regions is discussed. The aim is to provide a framework for discussion of capabilities and inadequecies and thereby define areas where effort should be assigned and perhaps also to serve as a useful source document for the newcomer to High Energy Physics. 74 refs.

39132 **(LA-UR—86-2055) Comparison of beta-ray polarizations in Fermi and Gamow-Teller transitions and SU(2)/sub L/ x SU(2)/sub R/ x U(1) models.** Herczeg, P. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 4p. (CONF-860575—9). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012416.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

SU(2)/sub L/ x SU(2)/sub R/ x U(1) models are analyzed via measurements of the ratio of beta-ray polarizations in Fermi and Gamow-Teller transitions. Results for this ratio had previously been interpreted only in the framework of manifestly left-right symmetric models. The investigation reported studies the implications of the ratio for more general models, including the most general one which allows for CP-violation, unequal left-handed and right-handed quark mixing angles, and mixing in the leptonic sector. For each case the corresponding constraints on the parameters are compared with constraints provided on them by other data. 7 refs. (LEW)

39133 **(LA-UR—86-2197) Search for rare muon and pion decay modes with the crystal box detector.** Piilonen, L.E.; Bolton, R.D.; Bowman, J.D.; Cooper, M.D; Frank, J.S.; Hallin, A.L.; Heusi, P.; Hoffman, C.M.; Hogan, G.E.; Mariam, F.G. (Los Alamos National Lab., NM (USA); Stanford Univ., CA (USA); Chicago Univ., IL (USA); Temple Univ., Philadelphia, PA (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-860575—12). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012436.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

New experiental upper limits for the branching ratios of the lepton-family-number nonconserving decays $\mu^+ \rightarrow e^+\gamma$ and $\mu^+ \rightarrow e^+\gamma\gamma$ are presented. A new determination of γ, the ratio of pion axial vector to vector form factors, from radiative pion decay is also reported. These results are from data taken with the Crystal Box detector at LAMPF. 11 refs., 7 figs.

39134 **(LA-UR—86-2283) New results for rare muon decays.** Mischke, R.E.; Bolton, R.D.; Bowman, J.D.; Cooper, M.D.; Frank, J.S.; Hallin, A.L.; Heusi, P.A.; Hoffman, C.M.; Hogan, G.E.; Mariam, F.G. (Los Alamos National Lab., NM (USA); Stanford Univ., CA (USA); Chicago Univ., IL (USA); Temple Univ., Philadelphia, PA (USA)). 1986. Contract W-7405-ENG-36. 6p. (CONF-860741—6). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012419.

From International symposium on weak and electromagnetic interactions in nuclei; Heidelberg, F.R. Germany (1 Jul 1986).

Branching-ratio limits obtained with the Crystal Box detector are presented for the rare muon decays $\mu \rightarrow eee$, $\mu \rightarrow e\gamma$, and $\mu \rightarrow e\gamma\gamma$. These decays, which violate the conservation of separate lepton-family numbers, are expected to occur in many extensions to the standard model. We found no candidates for the decay $\mu \rightarrow eee$, yielding an upper limit for the branching ratio of B/sub $\mu 3e/ < 3.1 \times 10^{-11}$ (90% C.L.). A maximum-likelihood analysis of the $\mu \rightarrow e\gamma$ candidates yields an upper limit of B/sub $\mu e\gamma/ < 4.9 \times 10^{-11}$ and an analogous analysis of $\mu \rightarrow e\gamma\gamma$ candidates gives an upper limit of B/sub $\mu e\gamma\gamma/ < 7.2 \times 10^{-11}$. These results strengthen the constraints on models that allow transitions between lepton families.

39135 **(LBL—21402) Do the cross sections for pp and p anti p continue to rise as $\log^2(s/s_0)$.** Block, M.M.; Cahn, R.N. (Northwestern Univ., Evanston, IL (USA). Dept. of Physics; Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098;AC02-76ER02289. 16p. (CONF-8603119—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012066.

From 21. Rencontre de Moriond: strong interactions and gauge theories conference; Les Arcs, France (16 Mar 1986).

A model-free analysis is made of the experimental total cross section, the ratio of real to imaginary portion of the forward nuclear scattering amplitude, and the nuclear slope parameter, for elastic scattering in proton-proton and proton-antiproton collisions, particularly in the low t region where t is the four-momentum transfer squared. The requirements of analyticity are compared with experimental data through direct use of analytic functions. It is found likely that the total cross section does not rise as $\log^2(s/s_0)$. (LEW)

39136 (NBS/SP—711, pp 1-10) **Particle properties of the neutron.** Ramsey, N.F. (Harvard Univ., Cambridge, MA). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

Particle properties of the neutron and experiments which have determined these properties are reviewed. Properties discussed include mass, electric charge, magnetic monopole, electric and magnetic dipole moments, neutron mean life for beta decay, ratio of axial vector coupling constants for the weak interaction, electric and magnetic polarizability, period for n anti n oscillations and various quantized properties such as spin, statistics and isospin. 58 refs.

39137 (NBS/SP—711, pp 25-30) **Implications of neutron beta-decay.** Byrne, J. (Univ. of Sussex, Brighton, England). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

An analysis is presented of the implications of results derived from the experimental study of neutron β-decay within the context of weak interaction theory. Comments on their significance in cosmology and astrophysics are offered. 22 refs.

39138 (NBS/SP—711, pp 31-35) **Review of the measurements of the neutron lifetime.** Robson, J.M. (McGill Univ., Montreal, Canada). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

A brief review is given of experiments which have measured the neutron lifetime. Some requirements which new experiments must satisfy are discussed. 12 refs., 6 figs.

39139 (NBS/SP—711, pp 42-47) **Determination of the neutron lifetime using e-p coincidence.** Wilkerson, J.F. (Los Alamos National Lab., NM). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

An experiment is being constructed to measure the neutron lifetime to better than 1% accuracy. The measurement will employ a novel experimental technique, a calorimetric measurement of the neutron flux. A sophisticated detector system is being used which should yield good signal to background discrimination. A summary of the experiment design is presented. 10 refs., 3 figs.

39140 (NBS/SP—711, pp 48-53) **Determination of the neutron lifetime by counting trapped protons.** Byrne, J.; Dawber, P.G.; Scott, R.D.; Robson, J.M.; Greene, G.L. (Univ. of Sussex, Brighton, England; Univ. of Glasgow, East Kilbride, Scotland; McGill Univ., Montreal, Canada; National Bureau of Standards, Gaithersburg, MD). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

A new experiment is proposed to determine the neutron lifetime by counting decay protons stored in an electromagnetic trap. Novel features of this technique, in the light of previous experience, is offered. 6 refs., 4 figs.

39141 (NBS/SP—711, pp 54-58) **In-beam neutron lifetime measurements at the Institut Laue-Langevin.** Dubbers, D. (Institut Max von Laue-Paul Langevin, Grenoble, France; Institut der Universitaet, Heidelberg, Germany). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

At the Institut Laue-Langevin there are at present two projects to measure the neutron lifetime "in beam," both using a rather long cold neutron beam volume. Two different methods to obtain the neutron lifetime from such measurements are mentioned. These are storage of the neutron in some kind of neutron bottle and measurement of the exponential decrease of their number as a function of a storage time and counting the neutron decay products near a beam of (preferentially cold) neutrons. The solution of problems associated with the second of these lifetime measurement techniques is discussed. 2 figs.

39142 (NBS/SP—711, pp 59-62) **Neutron lifetime measurements with bottled neutrons at ILL.** Mampe, W. (Institut Laue-Langevin, Grenoble, France). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

Two neutron lifetime experiments with storable neutrons are underway at the Institute Laue-Langevin, Grenoble: one version, prepared at the University of Bonn, will use the improved magnetic storage ring NESTOR on the new vertical guide. A second experiment is based on fluid walled material bottles of different surface to volume ratio. 7 refs., 2 figs.

39143 (NBS/SP—711, pp 63-68) **Correlation coefficients in polarized neutron decay: experiments with PERKEO.** Freedman, S.J. (Argonne National Lab., IL). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

High precision β-asymmetry experiments at the ILL using PERKEO have significantly reduced the error in nucleon vector and axial vector coupling constants. Unlike the direct neutron lifetime measurements, which formerly claimed the smallest errors in g/sub A/g/sub V/, the experiments that have measured the β-asymmetry are in good agreement. 8 refs., 4 figs., 1 tab.

39144 (NBS/SP—711, pp 69-74) **Time reversal invariance in polarized neutron beta decay.** Bowles, T.J. (Los Alamos National Lab., NM). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

The source of CP violation has been the subject of extensive experimental and theoretical work since its discovery in 1964. Measurements of the triple correlation σ/sub n/ (p/sub e/ x p/sub ν/) in polarized neutron beta decay have been carried out in attempts to define the cause of T (and CP) violation. Recent theoretical work has demonstrated the sensitivity of these measurements to CP violation arising in left-right symmetric models of the weak interaction. The status of previous experiments and theoretical work in polarized neutron beta decay is discussed along with plans for an experiment to substantially improve the sensitivity of the measurement of the triple correlation coefficient. 18 refs., 1 fig., 1 tab.

39145 (NBS/SP—711, pp 75-80) **Nucleon-nucleon weak interaction.** Adelberger, E.G. (Univ. of Washington, Seattle). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

The PNC NN interaction provides a unique window on flavor-conserving hadronic weak interactions. The current status of experiment and theory in this area are briefly discussed. 4 refs., 3 figs.

39146 (NBS/SP—711, pp 130-136) **Cold neutrons and neutron oscillations.** Ceolin, M.B. (Universita di Padova, Italy; Istituto Nazionale di Fisica Nucleare, Padova, Italy). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

The problem of neutron-antineutron oscillation experimental detection is discussed after a brief presentation of its phenomenology. Experiments deep underground with neutrons bound in nuclear matter are compared with experiments with artificially produced neutrons. Thermal, cold and ultracold neutrons are considered. It is concluded that cold neutrons, transported from the reactor to the experimental area through totally reflecting guides, reduce basically the radiation background, and allow, the other conditions being the same, a higher sensitivity. Finally some features of the experiment in preparation at the ILL reactor in Grenoble are summarized. 10 refs.

39147 (PITHA—84/17) **Measurement of the photon structure function F_2sup(γ) in the Q^2 range of 1.5-16 GeV^2.** Deuter, A. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Experimentalphysik 3B und 3. Physikalisches Inst.; Technische Hochschule Aachen (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet). 25 Jun 1984. 115p. (In German). NTIS, PC E11; Available from NTIS as TIB/B86-06564.

1417 events of the deep inelastic electron-photon scattering $e\gamma^+ \rightarrow e^+$ hadrons were measured for the determination of the photon structure function $F_2(X,Q^2)$ in the Q^2 range of $1.5<Q^2<16$ GeV^2. For the presentation of F_2 as function of X the measured quantity Xsub(vis) was transformed to X by outfolding of all detector effects. $F_2(X)$ is shown under inclusion of all events at a fixed $Q^2=5.3$ GeV^2. After partition of the data set into three Q^2 ranges (1.5-3, 3-6, 6-16 GeV^2) $F_2(X)$ at $Q^2=2.4$, 4.3, and 9.2 GeV^2 could be determined for the study of the Q^2 development. The results are well described by a hadronic contribution plus a point-shaped contribution calculated in QCD (next to leading order) both in the X ($0.1< x <0.9$) and in the Q^2 dependence. By a fit of the QCD prediction to the data Asub(anti Manti S) was determined to 210 +- 70(stat.) +- 60(syst.) MeV. Extreme limits for the hadronic model (F_2sup(had)=0, F_2sup(had)=0.2) fix Asub(anti Manti S) model-independently on a range $65<$Asub(anti Manti S)<575 MeV with 90% cl. By these limits αsub(S) can be extrapolated to the momentum transfer which is typical in the e^+e^- annihilation at PETRA

(Q^2=35 GeV^2). By this becomes 0.115<asub(S)<0.170. (orig./HSI).

39148 (TRI-PP—86-21) Searches for lepton flavor violation. Bryman, D. (TRIUMF, Vancouver, British Columbia (Canada)). Apr 1986. 13p. (CONF-860292—3). NTIS (US Sales Only), PC A02/MF A01. File Number DE86901489.

From Lake Louise winter institute in particle physics; Edmonton, Alberta, Canada (16 Feb 1986).

The present status of a selection of important lepton flavor violating (LFV) processes, mainly involving muon number violation, are briefly discussed, with indications of the special attractiveness of each. 44 refs., 11 figs. (LEW)

39149 (TRI-PP—86-22) Constraints on massive neutrinos from $\pi \rightarrow$ e nu decay. Britton, D.I. (TRIUMF, Vancouver, British Columbia (Canada)). Apr 1986. 5p. (CONF-860292—2). NTIS (US Sales Only), PC A02/MF A01. File Number DE86901490.

From Lake Louise winter institute in particle physics; Edmonton, Alberta, Canada (16 Feb 1986).

The positron energy spectrum from $\pi \rightarrow$ e nu decay has been searched looking for evidence of massive neutrinos. A new technique, developed to suppress the dominant π-μ-e decay chain background, has resulted in an order of magnitude improvement in the limits for the neutrino mass range 60 to 130 MeV.

39150 Search for single photons from radiative neutrino or supersymmetric-particle production. Ford, W.T.; Qi, N.; Read, A.L. Jr.; Smith, J.G.; Camporesi, T.; Peruzzi, I.; Piccolo, M.; Hurst, R.B.; Lau, K.H.; Pyrlik, J. (Department of Physics, University of Colorado, Boulder, Colorado 80309). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3472-3475(1 Jun 1986).

A search for single photons produced in association with neutrinos or other weakly interacting neutral particles has been performed in e^+e^- annihilations at $\sqrt{s}$ = 29 GeV with MAC detector at the SLAC e^+e^- storage ring PEP. One event is observed, with 1.1 events expected from the reaction $e^+e^- \rightarrow \nu$nu-bary. The number of neutrino families is restricted to N/sub ν/<17 at the 90% confidence level. Limits on possible masses of supersymmetric electrons (e) and photons (gamma-tilde) are presented. The e mass limit is m/sub e/>48 GeV/c^2 at the 90% confidence level if m/sub e//sub L/ = m/sub e//sub R/ and m/sub gamma-tilde/ = 0. If m/sub e//sub L/>>m/sub e//sub R/, the corresponding limit is m/sub e//sub R/>40 GeV/c^2.

39151 Measurement of the rate of formation of pi-mu atoms in K/sub L/^{0} decay. Aronson, S.H.; Bernstein, R.H.; Bock, G.J.; Cousins, R.D. Jr.; Greenhalgh, J.F.; Hedin, D.; Schwartz, M.; Shea, T.K.; Thomson, G.B.; Winstein, B. (Brookhaven National Laboratory, Upton, New York 11973). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3180-3198(1 Jun 1986).

Hydrogenlike atoms consisting of a pion and a muon can be formed in K/sub L/$^0 \rightarrow \pi\mu\nu$ decays. In an experiment at Fermilab, 320 pi-mu atoms were detected and simultaneouly the K/sub L/^{0} flux was monitored by recording ordinary K/sub L/$^0 \rightarrow \pi\mu\nu$ decays. The first measurement of the branching ratio R = Γ(K/sub L/$^0 \rightarrow$pi-mu atom+ν)/Γ(K/sub L/$^0 \rightarrow \pi\mu\nu$) = (3.90 +- 0.39) x 10^{-7} is reported, based on a subset of 155 atoms. This ratio may be sensitive to anomalous interactions between the pion and the muon. In the absence of such interactions, theory predicts R = (4.31 +- 0.06) x 10^{-7}.

39152 Observation of A dependence in Koba-Nielsen-Olesen scaling distributions for high-energy hadron-nucleus interactions. Biswas, N.N.; Ting, S.J.Y.; Mattingly, M.C.K.; Bishop, J.M.; Cason, N.M.; Kenney, V.P.; Ruchti, R.C.; Shephard, W.D.; Neale, W.W.; Elcombe, P.A. (University of Notre Dame, Notre Dame, Indiana 46556). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3167-3171(1 Jun 1986).

Experimental multiplicity distributions scaled in the Koba-Nielsen-Olesen (KNO) form for hadron-nucleus interactions show clear deviations from the scaling distribution observed for hadron-hadron interactions. The deviations become larger as A increases. Our data can be described by a model which invokes the hypothesis that KNO scaling is valid for hadron-nucleus interactions at a fixed impact parameter. In this model, the A dependence of the multiplicity distributions results from the convolution of scatterings at various impact parameters.

39153 Measurement of the resonance parameters and radiative width of the rho$^+$. Huston, J.; Berg, D.; Chandlee, C.; Cihangir, S.; Ferbel, T.; Jensen, T.; Lobkowicz, F.; McLaughlin, M.; Ohshima, T.; Slattery, P. (University of Rochester, Rochester, New York 14627). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3199-3202(1 Jun 1986).

We present the results of new precision measurements of the radiative decay width, total width, and mass of the rho$^+$ meson. These parameters are, respectively, 59.8 +- 4.0 keV, 0.150 +- 0.005 GeV, and 0.771 +- 0.004 GeV, and were extracted from data obtained on the coherent production of rho$^+$ in 200-GeV/c π^+ interactions with nuclear targets.

39154 Production of the f^0 meson in the Double Pomeron Exchange reaction pp->pp$\pi^+\pi^-$ at $\sqrt{s}$=62 GeV. Breakstone, A.; Crawley, H.B.; Firestone, A.; Gorbics, M.S.; Isenhower, L.D.; Lamsa, J.W.; Meyer, W.T.; Campanini, R.; Cuffiani, M.; Fabbri, F. (Ames Lab., IA, USA; Iowa State Univ. of Science and Technology, Ames, USA. Dept. of Physics). *Zeitschrift fuer Physik* [*Sektion*] *C: Particles and Fields;* **31**: No. 2, 185-190(Jun 1986). Contract AC03-76SF00098.

Data are presented for the exclusive reaction pp->pp$\pi^+\pi^-$ at $\sqrt{s}$=62 GeV with two leading protons at large Feynman-x and a centrally produced $\pi^+\pi^-$ system. In this kinematical configuration one expects a substantial contribution from Double Pomeron Exchange, which is a potential source of glueballs. The experiment was performed at the CERN ISR using the Split Field Magnet spectrometer. In the mass range between 1,000 and 1,700 MeV/c^2 the invariant mass distribution for the central PI$^+\pi^-$ system exhibits a very significant signal for the f^0(1270) and no other obvious resonant states.

39155 Search for nonspectator decays of the D^0. Baltrusaitis, R.M.; Becker, J.J.; Blaylock, G.T.; Brown, J.S.; Bunnell, K.O.; Burnett, T.H.; Cassell, R.E.; Coffman, D.; Cook, V.; Coward, D.H. (California Institute of Technology, Pasadena, California 91125; University of California at Santa Cruz, Santa Cruz, California 95064; University of Illinois at Urbana-Champaign, Urbana, Illinois 61801; Stanford Linear Accelerator Center, Stanford, California 94305; University of Washington). *Physical Review Letters;* **56**: No. 20, 2136-2139(19 May 1986). Contract AC03-76SF00515;AC02-76ER01195;AC03-81ER40050;AA03-76SF00034.

The weak hadronic decay D$^0 \rightarrow$K^{0}K$^+$K$^-$ is observed in a data sample of 9.3 pb^{-1} collected with the Mark III detector at the psi(3770) resonance. An analysis of the K$^+$K$^-$ subsystem suggests that while the decay proceeds in part through the K-bar^{0}phi channel, providing evidence for the presence of nonspectator amplitudes in D^0 decays, a significant fraction of the decays occur through both higher- and lower-mass K$^+$K$^-$ systems. A limit is set on the decay D$^0 \rightarrow$K^{0}K^0, also thought to proceed by nonspectator processes.

39156 Direct measurements of charmed-D-meson hadronic branching fractions. Baltrusaitis, R.M.; Becker, J.J.; Blaylock, G.T.; Brown, J.S.; Bunnell, K.O.; Burnett, T.H.; Cassell, R.E.; Coffman, D.; Cook, V.; Coward, D.H. (California Institute of Technology, Pasadena, California 91125; University of California at Santa Cruz, Santa Cruz, California 95064; University of Illinois at Urbana-Champaign, Urbana, Illinois 61801; Stanford Linear Accelerator Center, Stanford, California 94305; University of Washington). *Physical Review Letters;* **56**: No. 20, 2140-2143(19 May 1986). Contract AC03-76SF00515.

A new technique is applied to data collected at the psi(3770) resonance to derive charmed-D-meson branching fractions without

relying on the measurement of D-production cross sections. Measurements are presented for three decay modes of the D^0 ($K^-\pi^+$, $K^-\pi^-\pi^+\pi^+$, and $K^-\pi^+\pi^0$) and four decay modes of the D^+ ($K^-\pi^+\pi^+$, $K^-\pi^+\pi^+\pi^0$, K/sub S/$^0\pi^+$, and K/sub S/$^0\pi^+\pi^0$). The resulting branching fractions are significantly larger than previous measurements.

39157 Lifetime of D⁰ charmed mesons produced in neutrino interactions. Ushida, N.; Kondo, T.; Tasaka, S.; Park, I.G.; Song, J.S.; Hara, T.; Homma, Y.; Tsuzuki, Y.; Fujioka, G.; Fukushima, H. (Department of Physics, Aichi University of Education, Igaya-cho, Kariya-shi, Aichi 448, Japan). *Physical Review Letters;* **56**: No. 17, 1771-1774(28 Apr 1986).

We report final results for the D^0 lifetime measured with a hybrid emulsion spectrometer in the wide-band neutrino beam at Fermilab. In a total of 3886 neutrino and antineutrino interactions located in the emulsion fiducial volume, we have found 58 D^0 decays, from which we determine the lifetime to be (4.3 + 0.7 + 0.1/-0.5-0.2) x 10^{13} s.

39158 Wess-Zumino lagrangian and colored techni-pseudo-Goldstone bosons. McKay, D.W.; Young Binglin. (Kansas Univ., Lawrence, USA. Dept. of Physics and Astronomy; Ames Lab., IA, USA; Iowa State Univ. of Science and Technology, Ames, USA. Dept. of Physics). *Physics Letters [Section] B;* **169**: No. 1, 79-84(20 Mar 1986). Contract W-7405-ENG-82;AC02-79ER10528;FG02-85ER40214.

The construction of the Wess-Zumino type effective action is discussed for color octet techni-pion and techni-eta fields interacting with the light gauge bosons - gluon, photon, Wsup(+-) and Z. The explicit effective lagrangian for the one-pseudoscalar meson sector is displayed. GAMMA(eta->GWW), GAMMA(eta->GGγ) and GAMMA(eta->GGZ) are compared to GAMMA(eta->GZ) to illustrate the predictive content of the lagrangian. (orig.).

6452 Particle Interactions And Properties - Theoretical

REFER ALSO TO CITATION(S) 39017, 39043, 39132, 39193, 39197, 39198, 39200

39159 (ANL-HEP-CP—86-25) Gauginos from p anti p collisions. Baer, H.; Hagiwara, K.; Tata, X. (Argonne National Lab., IL (USA); Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Wisconsin Univ., Madison (USA). Dept. of Physics). Apr 1986. Contract W-31-109-ENG-38. 9p. (CONF-860292—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012128.

From Lake Louise winter institute in particle physics; Edmonton, Alberta, Canada (16 Feb 1986).

We investigate signals for winos and zinos when the decays W → wino + photino, Z → wino + antiwino, and W → wino + zino are allowed at proton-antiproton colliders. These processes lead to: (1) monojet and dijet plus missing transverse momentum (p/sub T/) events; (2) various di- and tri-lepton events with little accompanying hadronic activity; and (3) events containing jets plus leptons plus p/sub T/. Absence of such signals may allow new limits to be placed on m/sub wino/ and m/sub zino/ of at least m/sub wino/ + m/sub zino/ ≧ m/sub W/, from CERN collider data. 11 refs., 4 figs.

39160 (DESY—85-110) Two photon radiative widths of light mesons as a test of gauge theories with integrally charged quarks. Field, J.H. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Oct 1985. 91p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86752073.

A test is made of the quark charges using the recently measured 2γ widths of the pseudoscalar (π^0,eta,eta') and tensor (A_3,f,f') mesons. The model for GAMMAsub(γγ) is nonrelativistic quarkonium annihilation, including binding and SU(3) breaking corrections. The flavour mixing between the states (eta,eta',iota(1450)) or (f, f', THETA (1720)) is given by a linear quarkonium gluonium mass matrix which includes mass dependent SU(3) breaking corrections. For the pseudoscalars a fit is made to 5 experimental quantities sensitive to flavour mixing but independent of the quark charges. The best fit indicates a significant gluonium amplitude approx.= 0.6 in the eta'. The integral charge quark model is consistent with the measured value of GAMMAsub(γγ) (eta') only for the effective gluon masses <1.0 MeV/c^2 (95% C.L.). Corrections from radial excitations are discussed and it is concluded that a pure quarkonium radial excitation interpretation of the iota is unlikely. In the fractional charge model the measurements of GAMMAsub(γγ)(f,f',A_3) indicate that the f and f' are almost ideally mixed quarkonium states. In gauge integer charge models charged gluon annihilation may give large contributions to GAMMAsub(γγ)(f,f'). Such models are excluded by constraints from the strong decays f,f'->ππ, KK and the experimental upper limit on GAMMAsub(γγ)(THETA)BR(THETA->KK). Comparison of the fitted SU(3) breaking parameters with perturbative QCD expectations suggests Λ = 100 +- 50 MeV/c. (orig.).

39161 (DESY—85-113) Mass generation in composite models. Peccei, R.D. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Oct 1985. 32p. (CONF-8508151—3). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752064.

From INS international symposium on composite models of quarks and leptons; Tokyo, Japan (13 Aug 1985).

I discuss aspects of composite models of quarks and leptons connected with the dynamics of how these fermions acquire mass. Several issues related to the protection mechanisms necessary to keep quarks and leptons light are illustrated by means of concrete examples and a critical overview of suggestions for family replications is given. Some old and new ideas of how one may actually be able to generate small quark and lepton masses are examined, along with some of the difficulties they encounter in practice. (orig.).

39162 (DESY—85-122) Half integer charged hadrons from higher dimensions. Wetterich, C. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Nov 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752067.

Certain embeddings of the low energy SU(3)sub(C) x SU(2)sub(L) x U(1)sub(y) gauge group within the higher dimensional symmetry lead to exotic chiral generations in addition to a number of standard generations. We study an example leading to an anomaly free chiral exotic generation consisting of quarks with electric charge +1/6 and -5/6, the corresponding anti quarks and additional integer charged leptons. The most striking prediction from such a compactification would be the existence of stable half integer charged hadrons with mass of order of the Fermi scale. Detection of such particles would be an impressive hint for the existence of more than four dimensions. (orig.).

39163 (DESY—85-124) Strength of glueball interactions. Muenster, G. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Hamburg Univ. (Germany, F.R.). 2. Inst. fuer Theoretische Physik). Nov 1985. 9p. (CONF-8511196—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752068.

From International symposium on the theory of elementary particles; Ahrenshoop, German D.R. (17 Nov 1985).

The interaction strength between glueballs in a pure Yang-Mills theory is characterized by the triple glueball vertex function on-shell. This quantity is estimated by strong coupling methods. The result, which is in agreement with Monte Carlo calculations, indicates a rather strong interaction. Implications concerning finite size effects in mass calculations, the large N limit, and phenomenology of glueballs are discussed. (orig.).

39164 (DESY—85-133) Helicity amplitudes for heavy lepton production in e^+e^- annihilation. Hagiwara, K.; Zeppenfeld, D. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Durham Univ. (UK). Dept. of Physics). Dec 1985. 51p. (DTP—85/24). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752075.

Signatures of new heavy lepton pair production in e^+e^- annihilation at TRISTAN/SLC/LEP energies are studied in detail. Complete helicity amplitudes for the 2->6 process e^+e^- -> Lanti L -> (νsub(L)$f_1$anti f_2) (anti νsub(L)$f_3$anti f_4) are given for arbitrary masses of final fermions and for arbitrary vector and axial vector

couplings. Methods to measure the L and νsub(L) masses, and the neutral- and charged-current couplings of L in terms of four-jet and one-lepton-dijet final state distributions are exemplified. Signatures of heavy neutrino-pair production are discussed briefly. A straightforward method for calculating arbitrary tree amplitudes with external fermions and vector bosons of arbitrary masses is presented for completeness. (orig.).

39165 **(DESY—85-134) On the QCD 2->3 contributions to the hadroproduction of heavy quarks.** Glover, E.W.N.; Hagiwara, K.; Martin, A.D. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Durham Univ. (UK). Dept. of Physics; Cambridge Univ. (UK). Cavendish Lab.). Dec 1985. 17p. (DTP—85/26; HEP—85/8). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752074.

We examine in detail the use of tree level QCD 2->3 cross-sections for heavy quark production, which are known to give significant contributions to canti c and banti b production at hadron colliders. We present results for the 2->3 contributions which can be reliably calculated from QCD, namely (A) the production of three isolated high psub(T) jets, (B) heavy flavour excitation where only one of the heavy quarks has large Psub(T) and, (C) collinear heavy quark pair production where the pair form a single high psub(T) jet. There are no appreciable 2->3 contributions for t-quark production. (orig.).

39166 **(NBS/SP—711, pp 137-142) Ultracold neutrons and the search for the electric dipole moment of the neutron.** Pendlebury, J.M.; Smith, K.F. (Univ. of Sussex, Brighton, England). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

The present position on the search for the electric dipole moment (EDM) of the neutron is described and likely progress in the immediate future is discussed with reference to the ultracold neutron source requirements. Motivation for this research comes from the theoretical significance of the neutron EDM. Any mechanism which gives rise to an EDM in a free particle must involve the violation of parity P and time reversal symmetry T. The experimental apparatus at the Institut Laue-Langevin is described and problems associated with stability and systematic error are addressed. 15 refs., 3 figs.

39167 **(RAL—85-115) Particle physics and the standard cosmology.** Sarkar, S. (Oxford Univ. (UK). Dept. of Astrophysics; Rutherford Appleton Lab., Chilton (UK)). Dec 1985. 30p. (CONF-8506291—1). Rutherford Appleton Lab., Chilton, Didcot, OXON, OX11 OQX, England. File Number TI86901311.

From ICTP workshop on theoretical physics; Trieste, Italy (1 Jun 1985).

We review the constraints imposed by the standard cosmological model on physics beyond the standard SU(3)/sub C/ x SU(2)/sub L/ x U(1)/sub Y/ model, with particular attention to supersymmetry and supergravity.

39168 **(TRI-PP—86-23) Two photon decay widths of non-standard spin-0 bosons.** Bates, R.; Ng, J.; Kalyniak, P. (Carleton Univ., Ottawa, Ontario (Canada). Dept. of Physics; TRIUMF, Vancouver, British Columbia (Canada)). Apr 1986. 3p. (CONF-860292—4). NTIS (US Sales Only), PC A02/MF A01. File Number DE86901491.

From Lake Louise winter institute in particle physics; Edmonton, Alberta, Canada (16 Feb 1986).

The two photon decay widths of non-standard Higgs bosons are studied in a minimal broken supersymmetry model, and the two Higgs doublet extension of the standard model. A large enhancement of these widths relative to the standard model is possible. Supersymmetry imposes a severe constraint on this possible enhancement. The subsequent upper bounds on Higgs boson production rates via the two photon fusion mechanism are compared for ep and e^+e^- colliders.

39169 **Axion emission rates in stars and constraints on its mass.** Pantziris, A.; Kang, K. (Department of Physics, Brown University, Providence, Rhode Island 02912). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 12, 3509-3518(15 Jun 1986). Contract AC02-76ER03130.

We have calculated in detail the emission rates of the invisible axion of Dine, Fischler, and Srednicki in several representative types of stars and derived upper bounds for its mass. We give, in particular, complete reaction amplitudes and energy rates for axion emission. Our results for the axion mass limits are in qualitative agreement with previous estimates for most of the cases except for the neutron stars which give a stronger bound on the axion mass.

39170 **Signals for composite-W^{+-} production in γp collisions.** Rizzo, T.G. (Ames Laboratory and Department of Physics, Iowa State University, Ames, Iowa 50011). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3224-3227(1 Jun 1986). Contract W-7405-ENG-82.

We examine the possibility of observing the composite structure of W^{+-} bosons photoproduced in γp collisions at high energies through form-factor effects. We find that such processes are sensitive to W^{+-} compositeness scales as high as 3—5 TeV if sufficiently high luminosities are obtainable. Such reactions can be most easily studied by extracting a photon beam of energy ≃10 TeV from the Superconducting Super Collider (SSC) for collisions with a fixed target. This serves to indicate that new physical results are obtainable from the SSC even when used in a fixed-target mode.

39171 **Prediction of the electric form factors of the nucleon.** Mickens, R.E. (Department of Physics, Atlanta University, Atlanta, Georgia 30314). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3321-3323(1 Jun 1986).

We demonstrate that an analytic representation can be derived for the electric form factors of the nucleon which is consistent with the data. We use only known low-momentum-transfer (t = 0) and asymptotic (t→-∞) information on the behavior of these functions.

39172 **Bound on the W-boson electric dipole moment.** Marciano, W.J.; Queijeiro, A. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3449-3452(1 Jun 1986). Contract AC02-76CH00016.

A W-boson electric dipole moment λ/sub W/e/2m/sub W/ can induce fermion electric dipole moments via quantum loop corrections. Updating an analysis by Salzman and Salzman, we estimate this effect and find that the current neutron-electric-dipole-moment bound 'd/sub n/'$< 6 \times 10^{-20}$ e cm implies (barring an unforeseen cancellation) 'λ/sub W/'$< 1 \times 10^{-3}$ or 'd/sub W/'$< 10^{-19}$ e cm. On the basis of this constraint, we conclude that electric-dipole-moment contributions to radiative W-boson processes must be very small and effectively undetectable.

39173 **Quantum-electrodynamic radiative corrections to the decay $\pi 0 \to \gamma e^+ e^-$.** Roberts, L.; Smith, J. (Institute for Theoretical Physics, State University of New York at Stony Brook, Stony Brook, New York 11794-3840). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3457-3460(1 Jun 1986).

The quantum-electrodynamic radiative corrections to both the decay rate for $\pi \to \gamma e^+ e^-$ and the differential spectrum in the invariant mass of the Dalitz pair for experiments with limited geometrical acceptance are calculated.

39174 **Partons in nuclei.** Bickerstaff, R.P.; Birse, M.C.; Miller, G.A. (Institute for Nuclear Theory, Department of Physics, FM-15, University of Washington, Seattle, Washington 98195). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3228-3245(1 Jun 1986).

We study the different explanations of the European Muon Collaboration effect. Although the theoretical models are very sensitive to input free-nucleon structure functions, we find that each has distinctive testable traits. Therefore, we examine different reactions to see which can distinguish the models. Deep-inelastic (anti)neutrino-nucleus scattering data are examined, but we find that

the model differences to be exposed by this process are small. J/psi production in lepton-nucleus collision is, in principle, capable of determining the nuclear gluon distribution, but there are too many difficulties to successfully separate the different models. We find that the Drell-Yan process is better suited than antineutrino scattering to determine the nuclear ocean distributions. These may be studied in an experimentally accessible kinematic region in which a quark from the projectile annihilates with a nuclear antiquark.

39175 **Exotic fermions in E_6 and the anomalous magnetic moments of leptons.** Rizzo, T.G. (Ames Laboratory and Department of Physics, Iowa State University, Ames, Iowa 50011). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3329-3333(1 Jun 1986). Contract W-7405-ENG-82.

The mixing between the exotic fermions and the usual fermions (in E_6 theories) can lead to flavor-changing neutral currents. Such couplings can produce new and potentially large contributions to the anomalous magnetic moments of the electron and muon. We analyze these possibilities and comment on other processes (such as $\mu \rightarrow e\gamma$) which can be used to constrain E_6 theories.

39176 **Possible evidence for dynamical supersymmetry in the hadron spectrum.** Bohm, A. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3358-3367(1 Jun 1986).

A relativistic supersymmetric quantum mechanics is proposed which uses $Osp(1,4) \supset SO(3,2)$ for the spectrum and constrained Hamiltonian quantum mechanics for the dynamics of one-hadron systems. It combines baryon and meson towers into infinite supermultiplets in a way similar to the use of supersymmetries in nuclear physics. The predicted mass formula is fitted to the masses of baryon and meson resonances.

39177 **Inclusive nucleon-nucleus scattering and symmetric-hadron-pair production at high P/sub perpendicular/ in the relativistic quark model.** Khalil, A.E. (Institute of Nuclear and Particle Physics, Department of Physics, University of Virginia, Charlottesville, Virginia 22901). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3274-3278(1 Jun 1986). Contract AS05-78ER05861.

Inclusive cross sections for symmetric hadron pairs at large P/sub perpendicular/ are calculated in the framework of hard-scattering and scale-invariant quark-parton models. Our model does not reproduce the recent anomaly reported by Abramov for the reduction of the A-dependence exponent α for pion pairs produced with transverse momentum beyond 1.5 GeV/c.

39178 **Electromagnetic form factors in the Skyrme model.** Braaten, E.; Tse, S.; Willcox, C. (Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60201). *Physical Review Letters;* **56**: No. 19, 2008-2011(12 May 1986). Contract FG02-85ER40228.

The electric and magnetic form factors for the nucleon and the N-Δ transition are computed in the semiclassical approximation to the Skyrme model and compared with phenomenological dipole parametrizations. A model-independent relation between the magnetic form factors is obtained. The transverse electric transition form factor is identically zero in this approximation, while the longitudinal form factor is nonzero.

39179 **Laser-induced axion photoproduction.** Brodsky, S.J.; Mottola, E.; Muzinich, I.J.; Soldate, M. (Stanford Linear Accelerator Laboratory, Stanford University, Stanford, California 94305; Institute for Theoretical Physics, University of California, Santa Barbara, California 93106). *Physical Review Letters;* **56**: No. 17, 1763-1766(28 Apr 1986). Contract AC03-76SF00515.

Axion photoproduction, particularly laser and wiggler induced, is suggested as a systematic technique for probing the couplings of new elementary pseudoscalar (or scalar) particles in the megaelectron volt mass range to leptons, photons, and hadronic matter.

39180 **Small-x QCD and the ultra-high energy νN total cross section.** McKay, D.W.; Ralston, J.P. (Kansas Univ., Lawrence, USA. Dept. of Physics and Astronomy; Argonne National Lab., IL, USA. High Energy Physics Div.). *Physics Letters* [*Section*] *B;* **167**: No. 1, 103-107(30 Jan 1986). Contract W-31-109-ENG-38;FG02-85ER40214.

The calculation of the total neutrino-nucleon cross section at energies from 10 to 10^8 TeV is discussed. An extrapolation formula is developed which explicitly shows the enhancement at high energies due to QCD effects at small x. Our cross section is substantially larger than currently used extrapolation formulas. A comment on the possibility of cross-section enhancement by superheavy boson exchange is given and such a mechanism as applied to recent data from Cygnus X-3 is discussed.

6453 Particle Invariance Principles And Symmetries

REFER ALSO TO CITATION(S) 39144, 39145, 39176

39181 **(DESY—85-101) Large missing psub(T) events and supersymmetry.** Hagiwara, K. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Durham Univ. (UK). Dept. of Physics). Sep 1985. 20p. (CONF-8505229—3; DTP—85/22). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752070.

From New particles conference; Madison, WI, USA (8 May 1985).

Implications of large missing transverse momentum (psub(T)) events at the CERN panti p collider to supersymmetry theories are surveyed. Three popular models where photinos carry missing momentum, A) squark-pair scenario, B) gluino-pair scenario, and C) light-gluino scenario are critically reviewed. Both scenario A and B predict non-back-to-back dijet plus psub(T) events, whereas scenario C predicts monojet dominance at higher psub(T) (> or approx. 40 GeV) and back-to-back dijet events at moderate psub(T). Controversial problems in the light gluino scenario are discussed in detail. A model with neutral Higgsinos from the Z boson decay as the carrier of psub(T) is ruled out by e^+e^- experiments at PETRA. Light Goldstinos can also be a source of psub(T) in models where supersymmetry breaks down in the TeV energy region. If a Goldstino is the only light supersymmetric particle, then the large psub(T) event rate at $\sqrt{s}$=630 GeV is almost four times larger than that at $\sqrt{s}$=540 GeV. If both a Goldstino and a gluino are light (<1GeV), then we expect clean monojets with a quite hard psub(T) spectrum. (orig.).

39182 **(DESY—85-105) Non-perturbative contribution to the vacuum energy in supersymmetric QCD.** Mizrachi, L. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Sep 1985. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752071.

It is shown that instanton-anti-instanton induce a negative infrared finite vacuum energy in massless supersymmetric QCD. In the massive theory the same field configuration induces no vacuum energy because its classical action diverges due to the contribution of the mass term. Only if the scalar field is classically zero (in a background of an instanton-anti-instanton) a vacuum energy is found in the massive theory. However, it is negative and infrared divergent. (orig.).

39183 **(DESY—85-118) On the contribution of torons to the vacuum energy in Super-Yang-Mills theory.** Mizrachi, L. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Oct 1985. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752066.

Toron's contribution to the path integral in Super-Yang-Mills theory is calculated. A non-zero contribution is that of 3 torons and 3 anti-torons. The vacuum energy, however, is zero if the fluctuation region of the torons is finite. (orig.).

39184 (LA-UR—86-2135) Parity violation in proton-proton scattering at intermediate energies. Yuan, V.; Frauenfelder, H.; Harper, R.W.; Bowman, J.D.; Carlini, R.; MacArthur, D.W.; Mischke, R.E.; Nagle, D.E.; Talaga, R.L.; McDonald, A.B. (Illinois Univ., Urbana (USA); Los Alamos National Lab., NM (USA); Maryland Univ., College Park (USA); Princeton Univ., NJ (USA)). May 1986. Contract W-7405-ENG-36. 6p. (CONF-860575—11). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012402.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

Results of a measurement of parity nonconservation in the anti p-p total cross sections at 800-MeV are presented. The dependence of transmission on beam properties and correction for systematic errors are discussed. The measured longitudinal asymmetry is A/sub L/ = (+2.4 +- 1.1(statistical) +- 0.1(systematic)) x 10^{-7}. A proposed experiment at 230 MeV is discussed. 16 refs., 1 fig.

39185 (NBS/SP—711, pp 81-84) Tests of T-invariance with slow neutrons. Kabir, P.K. (Univ. of Virginia, Charlottesville). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

The polarization of neutrons propagating through a medium with spin-polarization S-vector may undergo precession about and towards [k-vector x S-vector]. Either effect is an unambiguous indicator of T-noninvariance. For S $\geq$ 1, a similar effect, requiring target spin-alignment only, occurs if there are suitable T-nonvariant interactions even if these conserve parity exactly. 10 refs.

39186 (NBS/SP—711, pp 85-89) Parity violation in capture of polarized neutrons. Wilson, R.; Avenier, M.; Bagieu, G.; Hart, R.; Koang, D.H.; Idrissi, M.A.; Vignon, B. (Harvard Univ., Cambridge, MA; Institut des Sciences Nucleaires, Grenoble, France). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

The work of the last five years on capture of polarized nuclei is briefly summarized. The accuracy in H and D is limited by statistical accuracy and therefore the beam intensity. It is shown A/sub γ//sup np/ to be measured to +-3 x 10^{-9} where a significant effects is expected. 10 refs.

39187 (NBS/SP—711, pp 90-94) PNC and TNC rotations of the neutron spin. Heckel, B. (Univ. of Washington, Seattle). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

Parity (P) non-conserving and time reversal symmetry (T) nonconserving forces can give rise to P-odd and T-odd rotations of the neutron spin as the neutron propagates through a material target. Measurements of polarized neutron transmission through heavy nuclear targets have observed enhanced P-odd rotations due to pnc mixing between compound resonances. Similar resonant enhancements are expected for measurements of T-odd neutron spin rotations. Measurements of the P-odd rotation in light nuclear targets (H, D, and ^{4}He) can provide useful information about the nucleon-nucleon weak interaction. 25 refs.

39188 Super-Kac-Moody algebras and supersymmetric 2d-free fermions. Windey, P. (Lawrence Berkeley Lab., CA, USA; California Univ., Berkeley, USA. Dept. of Physics). *Communications in Mathematical Physics;* **105**: No. 4, 511-518(Jul 1986). Contract AC03-76SF00098.

Explicit representations of super-Kac-Moody algebra are constructed in terms of 2d-free fermions which form a non-linear representation of supersymmetry with the fermions grouped with the generators of the algebra into superfields. It is shown how the most general construction of this type corresponds to homogeneous spaces G/H and how supersymmetry alone is responsible for that structure.

39189 Spontaneous breaking of parity in (2 + 1)-dimensional QED. Appelquist, T.; Bowick, M.J.; Karabali, D.; Wijewardhana, L.C.R. (Yale University, Physics Department, New Haven, Connecticut). *Physical Review [Section] D: Particles and Fields;* **33**: No. 12, 3774-3776(15 Jun 1986). Contract AC02-76ER03075.

The spontaneous generation of parity- (P) and time-reversal- (T) violating masses in (2+1)-dimensional QED is studied in the large-N limit, where N is the number of two-component complex fermions. Energy considerations of various symmetry-breaking patterns indicate that P and T are not spontaneously broken, even though masses which individually violate these symmetries are dynamically generated.

39190 Higgs-boson masses in a supersymmetric extension of the standard model. Babu, K.S.; Ma, E. (Department of Physics and Astronomy, University of Hawaii at Manoa, Honolulu, Hawaii 96822). *Physical Review [Section] D: Particles and Fields;* **33**: No. 11, 3334-3337(1 Jun 1986). Contract AM03-76SF00235.

We consider a supersymmetric extension of the standard model with two Higgs-boson doublets and a singlet, and analyze the resulting Higgs-boson mass spectrum from the spontaneous breaking of the gauge symmetry. If we also require the two extra dimensionless couplings in this model to be bounded as functions of the renormalization point for as long as the U(1) gauge coupling is bounded, then at least one physical neutral Higgs boson must have a mass less than 134 GeV, even in the presence of the most general explicit soft breaking of the supersymmetry.

39191 Transverse-polarization effects in e^+e^- collisions: The role of chiral symmetry. Hikasa, K. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706). *Physical Review [Section] D: Particles and Fields;* **33**: No. 11, 3203-3223(1 Jun 1986).

Electrons and positrons in storage rings have natural polarization which is perpendicular to the beam direction. Effects of the transverse polarization to azimuthally integrated cross sections are studied. In the standard model, the polarization does not affect the cross section up to a correction proportional to the electron mass, which is negligible at high energies. This fact is closely related to the chiral symmetry of the standard model. It is not necessarily true if there are new interactions beyond the standard model. Polarization effects in composite and supersymmetric models are studied in detail. New particles such as scalar bosons and excited electrons in composite models can give nonzero polarization effects. In supersymmetric theories, the transverse polarization is useful to probe the mixing of the scalar-electron states. The nonvanishing effects are connected to the breaking of the chiral symmetry by the new interactions.

39192 Supplementary evidence for T violation. Sachs, R.G. (Enrico Fermi Institute and the Department of Physics, The University of Chicago, 5640 South Ellis Avenue, Chicago, Illinois 60637). *Physical Review [Section] D: Particles and Fields;* **33**: No. 11, 3283-3292(1 Jun 1986). Contract AC02-80ER10587.

The only significant experimental evidence for T violation is based on the data on CP violation and other measured properties of the decay amplitudes of neutral K mesons and their combined use in an analysis based on the Bell-Steinberger unitarity relation or its equivalent. It has been pointed out by Kenny and Sachs that there is a technical possibility that this conclusion can be evaded because the argument depends on the assumption that the effective (phenomenological) weak-interaction Hamiltonian from which the decay amplitudes are derived is Hermitian. The purpose of this paper is to show that this assumption can be circumvented by making use of additional data on the unitarity of the decay amplitudes of both the neutral and charged K mesons to establish an upper limit on the magnitude of amplitudes associated with T-invariant anti-Hermitian interactions. It is assumed that the order of magnitude of such terms is in conformity with the values expected on the basis of the usual approximate isotopic spin selection rules for the weak interactions. Then it is found that if all the relevant weak interactions are T invariant, the data on unitarity would place

an upper limit on the CP-violation parameter 'eta/sub +/-' of 'eta/sub +/-' $<0.34 \times 10^{-3}$, which is an order of magnitude smaller than the observed value. It is therefore found that the possibility of including in the analysis a non-Hermitian effective weak Hamiltonian up to the limit permitted by the data on unitarity does not alter the conclusion that T invariance is violated.

39193 **Discriminating horizontal symmetries from operator analysis and proton-decay experiments.** Bandyopadhyay, K.; Ray, A.K.; Sarkar, U. (Department of Physics, Visva-Bharati University, Santiniketan 731235, West Bengal, India). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3293-3305(1 Jun 1986). Contract FG05-85ER40200.

The impact of different horizontal symmetries on nucleon decay is discussed within the framework of the standard and the left-right-symmetric theory. Under very general assumptions of operator analysis, it is demonstrated that U(1)/sub H/, SU(2)/sub H/, SU(3)/sub H//sup V/L, and SU(3)/sub H//sup V/ symmetries predict different nucleon decay modes and, hence, the on-going proton-decay experiments can be used to discriminate among the different horizontal symmetries. Furthermore, it is shown that, under favorable situations, the standard and the left-right-symmetric theory can also be distinguished.

39194 **Lattice gauge-Higgs theories with localxglobal symmetry groups: General properties and exact solutions.** Shrock, R.E. (Physics Department, Ohio State University, Columbus, Ohio 43210; Institute for Theoretical Physics, State University of New York, Stony Brook, New York 11794). *Physical Review Letters;* **56**: No. 20, 2124-2127(19 May 1986). Contract AC02-76ER01545.

We discuss a class of lattice gauge-Higgs models with local x global symmetry groups and present an exact solution for a class of 2D theories. The latter constitute the first nontrivial exactly solved lattice gauge-Higgs models.

6454 Field Theory

REFER ALSO TO CITATION(S) 39045, 39105, 39173, 39174, 39175, 39178, 39189, 39190, 39191, 39194, 39290

39195 **(DESY—85-108) First evidence for the existence of instantons in the quantized SU(2) lattice vacuum.** Ilgenfritz, E.M.; Mueller-Preussker, M.; Schierholz, G.; Schiller, H.; Laursen, M.L. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Karl-Marx-Universitaet, Leipzig (German Democratic Republic). Sektion Physik; Humboldt-Universitaet, Berlin (German Democratic Republic). Sektion Physik; Akademie der Wissenschaften der DDR, Berlin-Zeuthen. Inst. fuer Hochenergiephysik). Oct 1985. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752072.

Starting from Monte Carlo generated equilibrium gauge field configurations at $\beta=2.1$ and 2.2 on a 6^4 lattice, representing the physical vacuum, we systematically freeze the quantum fluctuations by means of successive relaxation. The result is that we obtain (approximate) solutions of the classical equations of motion, which turn out to have discrete values of the action in close agreement with the continuum (multi-) instanton solutions. We show that these 'lattice (multi-) instantons' are localized in space-time, that they carry a topological charge /Q/=N and that they give rise to a number of fermion zero modes in accordance with the Atiyah-Singer index theorem. Finally, we estimate the 'background topological susceptibility' from the distribution of lattice (multi-) instantons. (orig./HSI).

39196 **(SLAC-PUB—3961) Superstrings and geometry of superspace.** Dhar, A. (Stanford Linear Accelerator Center, Menlo Park, CA (USA)). May 1986. Contract AC03-76SF00515. 13p. (CONF-860175—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012044.

From Tata Institute winter school on theoretical particle physics; Panchgani, India (25 Jan 1986).

These lectures present some recent developments in the σ-model approach to the Green-Schwarzsuperstring. Among the topics included are: (1) interpretation of the free superstring as a flat superspace σ-model; (2) propagation of the superstring in curved superspace; and (3) in the presence of background super Yang-Mills fields. The role of the world-sheet fermionic gauge symmetry needed to ensure consistent coupling to background fields is emphasized. 24 refs.

39197 **Interacting parastrings.** Ardalan, F.; Mansouri, F. (Physics Department, Sharif University of Technology, Tehran, Iran). *Physical Review Letters;* **56**: No. 23, 2456-2458(9 Jun 1986). Contract AC02-76ER02978.

Interacting parastrings offer the alternative of constructing string theories directly in four (as well as a number of other) space-time dimensions. These theories are consistent with Lorentz invariance, Lovelace analyticity, and modular invariance. They are also derivable from actions in light-cone gauge. For supersymmetric parastrings, the corresponding actions are supersymmetric.

39198 **Monte Carlo simulation of jets in the upsilon and t-quarkonium regions.** Ng, C. (Department of Physics, University of Illinois at Urbana-Champaign, 1110 W. Green Street, Urbana, Illinois 61801). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3246-3255(1 Jun 1986). Contract AC02-76ER01195.

We apply Webber's QCD branching Monte Carlo model to study the properties of jets produced in upsilon decay and the nearby continuum e^+e^- annihilations. In general, agreement between the Monte Carlo simulation and data is obtained. More baryons are produced in upsilon decay than in the continuum annihilation because there are more heavy colorless clusters in the configuration of upsilon decay. We then investigate the various decay mechanisms of t-quarkonium. The heavy-particle spectra are found to be quite different for various decay modes of t-quarkonium.

39199 **CP violation and generation mixing.** Gronau, M.; Gupta, V.; Johnson, R.; Schechter, J. (Physics Department, Technion, 32000 Haifa, Israel). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3368-3373(1 Jun 1986). Contract FG02-85ER40231.

We explore the possibility of defining maximal CP violation by requiring that generation mixing disappears when the CP-violating terms go to zero in the standard model. This leads to a family of cases related to "different CP operations being maximized" and corresponding to the existing variety of proposals for mixing matrix parametrizations. A favored choice, useful for model building, seems to emerge.

39200 **Energy and Regge residues in quantum-mechanical "QCD" sum rules.** Durand, B.; Durand, L. (Physics Department, University of Wisconsin, Madison, Wisconsin 53706). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 11, 3441-3448(1 Jun 1986). Contract AC02-76ER00881.

It was shown recently by Fishbane, Kaus, and Gasiorowicz that the residues at the poles of quantum-mechanical two-point functions for arbitrary angular momenta l have an incorrect l dependence when calculated by the sum-rule method used for the analogous problem in QCD. Knowledge of the residues is of interest since they are directly related to particle couplings and decay widths. We develop reliable expressions for the energy and Regge residues using semiclassical methods.

39201 **Quark-Gluon transport theory II. color response and color correlations in a Quark-Gluon plasma.** (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973). *Annals of Physics (New York);* **168**: No. 1, 148-181(15 Apr 1986). Contract AC02-76CH00016.

Starting from a classical kinetic description of the quark-gluon plasma, we derive in the linear response approximation the color response function near thermodynamic equilibrium. From its poles the dispersion relations for the collective color modes (one longitudinal and one transverse) are obtained. The absence of Landau damping in the quark-gluon plasma is shown, and other damping mechanisms are discussed. A common misunderstanding concerning Landau damping in an electron plasma at low momenta is clarified. Finally we find the color correlation function in an equilibrium QCD plasma, using the fluctuation-dissipation theorem.

Its relation to the gluon polarization operator in finite temperature QCD is discussed. The coefficient for color transport (color conductivity) is determined within a relaxation time model. Possible applications in the computation of plasma observables are pointed out.

39202 **Phase transitions in a saturating chiral theory of nuclear matter.** (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Annals of Physics (New York);* 168: No. 1, 246-269(15 Apr 1986). Contract AC03-76SF00098.

The formalism of a relativistically covariant saturating chiral field theory of nuclear matter is developed in the mean approximation, and some of the properties are studied. The theory possesses the normal saturated state of nuclear matter. The finite temperature properties are examined. A normal gas-liquid phase equilibrium region exists below T-italic roughly-equal 23 MeV. The maximum mass for a neutron star is calculated, and it lies well above the lower bound set by observation. In the high-temperature regime, there is a second minimum in the free energy, on which branch the effective baryon mass is very small. However, this branch is everywhere mechanically unstable, and so is not a realizable state of the theory. Above a certain critical temperature there is in fact no stable state at low baryon density. There is no density or temperature regime where chiral symmetry is restored.

6455 Scattering Theory

39203 **(N—86-21297) Second quantization techniques in the scattering of nonidentical composite bodies.** Norbury, J.W.; Townsend, L.W.; Deutchman, P.A. (National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center). Jan 1986. 18p. NTIS, PC A02/MF A01.

Second quantization techniques for describing elastic and inelastic interactions between nonidentical composite bodies are presented and are applied to nucleus-nucleus collisions involving ground-state and one-particle-one-hole excitations. Evaluations of the resultant collision matrix elements are made through use of Wick's theorem.

65 PHYSICS II

6510 Nuclear Physics

REFER ALSO TO CITATION(S) 39102, 39304

39204 **(ECN—182) Processing of double-differential cross sections in the new ENDF-VI format. GROUPXS code description and users' manual.** Gruppelaar, H.; Nierop, D.; Akkermans, J.M. (Netherlands Energy Research Foundation, Petten). Apr 1986. 60p. ECN, P.O. Box 1, 1755 ZG Petten, Netherlands. File Number DE86752541.

For the file handling and processing of the double-differential continuum-emission cross sections stored in the new MF6 format of ENDF-VI a special code has been written. This code named GROUPXS has the following options to treat the energy-angle data that are supposed to be represented by a Legendre-polynomial expansion in the center-of-mass system: (1) Conversion of MF6 data from center-of-mass system to laboratory system, with the possibility to continue the calculation with options (2), (3) or (4). (2) Conversion of Legendre-polynomial representation into point-wise angular data, again in MF6 format. (3) Conversion of data from MF6 into MF4 + MF5 (ENDF-V). (4) Calculation of group constants, scattering matrices and transfer matrices for arbitrary group structures with a fusion micro-flux weighting spectrum (P/sub N/-approximation). The code only treats continuum reaction types that are stored in the MF6 format with the restrictions as specified for the European Fusion File (EFF). These restrictions are not inconvenient for the purpose of fusion-neutronics calculations and they facilitate relatively simple processing. The report contains a code description and a users' manual. 21 refs., 9 tabs.

39205 **(LBL—21336) Heavy ion fusion reactions in perspective.** Randrup, J. (Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098. 11p. (CONF-860396—10). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011561.

From Symposium on the many facets of heavy ion fusion reactions; Argonne, IL, USA (24 Mar 1986).

An attempt is made to summarize research in heavy ion fusion reactions. Fusion is defined and remarks are made concerning sub- and near-barrier fusion, probing the spin distribution of fusion products, limitations to fusion, quasi-fission reactions, complex-fragment emission, incomplete momentum transfer, models for prequilibrium phenomena, and molecular dynamics. Progress and problems associated with these topics are mentioned. The general importance of this research to other fields is also outlined. (DWL)

39206 **(NBS/SP—711) Investigation of fundamental interactions with cold neutrons. Proceedings of a workshop. NBS Special Publication 711.** Greene, G.L. (ed.). (National Bureau of Standards, Washington, DC (USA)). Feb 1986. 166p. (CONF-8511137—). NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86009521.

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

The purpose of the workshop was to provide guidance for a new National Cold Neutron Facility at the 20 MW research reactor at the National Bureau of Standard campus in Gaithersburg, Maryland. Separate abstracts were prepared for 25 papers in this report. (DWL)

6511 Experimental Techniques

REFER ALSO TO CITATION(S) 38719, 38720

39207 **(LA-UR—86-2098) Studies of nuclear structure in antinucleon charge-exchange reactions.** Auerbach, N. (Los Alamos National Lab., NM (USA); Tel Aviv Univ. (Israel). Dept. of Physics and Astronomy). 1986. Contract W-7405-ENG-36. 7p. (CONF-860575—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012410.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

The antinucleon-nucleus charge exchange reaction is discussed an its use as a probe of isovector excitations in nuclei is described. Attention is drawn to the fact that the (anti p,anti n) reaction will predominantly excite "pionic" (i.e., longitudinal spin) modes in nuclei. Comparison between (anti p,anti n) and (n,p) reactions is made. Plans for (anti p,anti n) experiments in the near future are mentioned. 21 refs., 3 figs.

39208 (NBS/SP—711, pp 95-105) **Neutron interferometry: present status - future prospects.** Werner, S.A.; Kaiser, H. (Univ. of Missouri, Columbia). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

In this paper we enumerate the wide range of experiments carried out to-date using the Bonse-Hart perfect-silicon-crystal x-ray interferometer; which includes gravitationally-induced quantum interference, the effect of the Earth's rotation on the quantum mechanical phase of the neutron (Sagnac Effect), the observability of 2π-rotation of fermions, spin superposition (Wigner phenomenon), the neutron Fizeau effect, search for quaternions in quantum mechanics, and a search for nonlinear terms in the Schroedinger equation. Plans are underway for a neutron Michelson-Morley experiment, various versions of a Wheeler delayed-choice experiment and for the construction of very large-scale interferometers approaching linear dimensions of 1 meter. 21 refs., 4 figs., 1 tab.

39209 (NBS/SP—711, pp 106-111) **Perfect crystal systems for advanced interferometer and resonator devices.** Rauch, H. (Atominstitut der Oesterreichischen Universitaeten, Vienna, Austria). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

Multi-plate interferometry is discussed in respect to new kinds of phase echo systems and delayed choice experiments. For pulsed sources various resonators systems using crystals are discussed which become more powerful by a combination with active energy shift devices. 25 refs., 5 figs.

39210 **Nuclear physics in the 10—300 MeV energy range using a pulsed white neutron source.** Bowman, C.D.; Wender, S.A.; Auchampaugh, G.F. (Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 259-273(20 Jan 1985). (CONF-840945—).

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

A new pulsed white neutron source is under construction at the Los Alamos WNR facility. The neutrons are produced by LAMPF proton micropulses striking thick targets of various materials. Beam parameters include energy of 800 MeV, pulse rate of approximately 50,000 Hz, 0.4 nsec pulse width, average current as high as 6μa, and a useful neutron energy range from 3 to 300 MeV. The facility will receive beam approximately 80% of the time LAMPF is operational; it increases by a factor of 1000 the experimental capability over the present system at the WNR when beam intensity, angular distribution, and availability are taken into account. In addition to established white source techniques, the facility is also highly competitive with monoenergetic sources for a wide class of experiments such as neutron capture γ ray spectroscopy and neutron-induced charged particle reactions. The facility should be operational in about nine months. Arrangements are underway to make the facility readily accessible to visiting experiments.

6512 Nuclear Properties And Reactions, A=1-5, Theoretical

39211 **(TRI-PP—86-19) Three-particle systems at low and intermediate energies.** van Oers, W.T.H. (Manitoba Univ., Winnipeg (Canada). Dept. of Physics). Apr 1986. 8p. (CONF-8604194—3). NTIS (US Sales Only), PC A02/MF A01. File Number DE86901485.

From International symposium on three-body force in the three-nucleon system; Washington, DC, USA (24 Apr 1986).

Recent experimental investigations of systems consisting of three nucleons or of a pion and two nucleons are commented on. Sensitivities with regard to the nucleon-nucleon and pion-nucleon interactions are discussed. Discrepancies between experimental observables and theoretical predictions do not require the inclusion of explicit three-body forces at the present level of precision.

6513 Nuclear Properties And Reactions, A=6-19, Theoretical

REFER ALSO TO CITATION(S) 39047, 39261

39212 **(KFK—3977) Single nucleon transfer reactions in ^{6}Li+^{6}Li collisions at 156 MeV.** Micek, S.; Klewe-Nebenius, H.; Rebel, H.; Gils, H.J.; Zagromski, S.; Srivastava, D.K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Kernphysik; Uniwersytet Jagiellonski, Krakow (Poland). Inst. Fizyki; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Radiochemie). Oct 1985. 17p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752082.

Single nucleon transfer reactions in collisions of 156 MeV ^{6}Li ions with ^{6}Li nuclei, leading to unstable final nuclei (^{5}Li, ^{5}He) have been experimentally studied. The measured ^{6}Li(^{6}Li, ^{7}Li)^{5}Lisub(gr) and ^{6}Li(^{6}Li, ^{7}Be)^{5}Hesub(gr) differential cross sections have been analysed on the basis of a FR-DWBA procedure, extracting information about the optical potentials acting in the exit channel. (orig.).

39213 **Nuclear wave function considerations in pion photoproduction.** Singham, M.K. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 6, 2194-2196(Jun 1986).

We find that the measured values of the angular distributions for the reaction ^{12}C(γ,π^{+})^{12}B /sub g.s./ can be reasonably well reproduced provided that (i) nuclear wave functions constrained to fit a wide range of weak and electromagnetic data are used and (ii) the Δ-isobar term in the Blomqvist-Laget photoproduction operator is omitted. All calculations were done in the 1p-shell model space, suggesting that core polarization contributions are much smaller than previously estimated.

39214 **Pion single charge exchange on ^{14}C from 35 to 295 MeV.** Ullmann, J.L.; Alons, P.W.F.; Kraushaar, J.J.; Mitchell, J.H.; Peterson, R.J.; Ristinen, R.A.; Knudson, J.N.; Comfort, J.R.; Baer, H.W.; Bowman, J.D. (Department of Physics, University of Colorado, Boulder, Colorado 80309). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 6, 2092-2104(Jun 1986).

The ^{14}C(π^{+},π^{0}) ^{14}N reaction to the isobaric analog state has been studied at pion energies between 35 and 100 MeV as an extension of earlier measurements at 100 to 295 MeV. Absolute differential cross sections were measured over the 0°—25° angular range, except at 49.3 MeV, where the range was extended to 75°. A deep minimum was found in the 0° excitation function near 50 MeV, similar to that in the π^{-}p→π^{0}n excitation function due to the near cancellation of the S- and P-wave contributions. A comparison of the data with several theoretical models is presented.

39215 **(n,p) reaction at zero degrees from ^{12}C, ^{13}C, ^{90}Zr, and ^{209}Bi at 65 MeV.** Ford, T.D.; Brady, F.P.; Castaneda, C.M.; Romero, J.L.; Drummond, J.R.; McEachern, B.; Webb, M.L.; King, N.S.P.; Martoff, J.; Wang, K. (Department of Physics and Crocker Nuclear Laboratory, University of California, Davis, California 95616). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 141-142(20 Jan 1985). (CONF-840945—).

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

The first spectra from the UC Davis cyclotron's zero degree facility for (n,p) scattering have been obtained from ^{12}C, ^{13}C, ^{90}Zr, and ^{209}Bi at an incident neutron energy of 65 MeV. Cross sections for the ground state, the ~4.4 MeV and the GDR are extracted for the carbon isotopes. Two broad resonances in ^{209}Bi at ~7.5 MeV and ~15 MeV and a broad resonance in ^{90}Zr at ~22 MeV are compared with previous work done at Davis away from zero degrees.

39216 **Neutron scattering on deformed nuclei.** Hansen, L.F.; Haight, R.C.; Pohl, B.A.; Wong, C.; Lagrange, C. (Lawrence Livermore National Laboratory, Livermore, CA 94550). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 314-317(20 Jan 1985). (CONF-840945—). Contract W-7405-ENG-48.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

Measurements of neutron elastic and inelastic differential cross sections around 14 MeV for ^{9}Be, C, ^{181}Ta, ^{232}Th, ^{238}U, and ^{239}Pu have been analyzed using a coupled channel (CC) formalism for deformed nuclei and phenomenological global optical model potentials (OMP). For the actinide targets these results are compared with the predictions of a semi-microscopic calculation using Jeukenne, Lejeune, and Mahaux (JLM) microscopic OMP and a deformed ground state nuclear density. The overall agreement between calculations and the measurements is reasonably good even for the very light nuclei, where the quality of the fits is better than those obtained with spherical OMP.

6514 Nuclear Properties And Reactions, A=20-38, Theoretical

39217 (LBL—21452) Microscopic model of nucleus-nucleus collisions. Harvey, B.G. (Lawrence Berkeley Lab., CA (USA)). Apr 1986. Contract AC03-76SF00098. 9p. (CONF-860506—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012019.

From International conference on heavy ion nuclear collisions in the fermi energy domain; Caen, France (12 May 1986).

The collision of two nuclei is treated as a collection of collisions between the nucleons of the projectile and those of the target nucleus. The primary projectile fragments contain only those nucleons that did not undergo a collision. The inclusive and coincidence cross sections result from the decay of the excited primary fragments. 15 refs., 5 figs.

39218 ^{26}Al(n,p)^{26}Mg reaction: Comparison between the Hauser-Feshbach formula and the exact random-matrix result for the cross section. Thomas, J.; Zirnbauer, M.R.; Langanke, K. (Norman Bridge Laboratory of Physics, California Institute of Technology, Pasadena, California 91125). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 2197-2199(Jun 1986).

We have calculated the ^{26}Al(n,p)^{26}Mg reaction rate using an exact expression for the compound-nucleus cross section derived recently by Verbaarschot et al. This reaction is astrophysically important, and it happens to fall in a kinematic regime where the exact expression is expected to yield large deviations from the standard Hauser-Feshbach formula. We find that the exact statistical cross section is 20% lower at energies greater than 300 keV, and drops to 40% lower at 0 energy but still does not describe the available data. These deviations are quite similar to those predicted by the formula of Tepel et al.

39219 Nuclear structure effects in preequilibrium reactions: α-induced reactions on /sup 24,25,26/Mg, ^{27}Al, and ^{28}Si. Machner, H.; Seniwongse, G.; Jahn, P.; Nolte, M.; Rogge, M.; Turek, P. (Institut fuer Kernphysik, Kernforschungsanlage Juelich, D-5170 Juelich, Federal Republic of Germany). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 1931-1942(Jun 1986).

We have measured charged particle spectra from 100 MeV α-induced reactions on targets of /sup 24,25,26/Mg, ^{27}Al, and ^{28}Si. The charged particles are protons, deuterons, tritons, ^{3}He, and α particles. The cross sections were analyzed in the framework of the exciton coalescence model. The data suggest complex particle formation to be independent of individual nuclear structure. The deduced single-particle state densities show strong odd-even effects.

39220 One-nucleon-transfer reactions induced by 352-MeV ^{18}O on ^{28}Si. Fernandes, M.A.G.; Burks, B.L.; Horen, D.J.; Satchler, G.R.; Auble, R.L.; Bertrand, F.E.; Blankenship, J.L.; Ford, J.L.C. Jr.; Gross, E.E.; Hensley, D.C. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 1971-1982(Jun 1986).

The one-nucleon transfer reactions ^{28}Si(^{18}O,^{17}O)^{29}Si and ^{28}Si(^{18}O,^{19}F)^{27}Al have been studied at 352 MeV bombarding energy. Several strong transitions were identified in each reaction and analyzed using the distorted-wave Born approximation. A shallow, surface-transparent optical potential of E-18 type did not give acceptable results, but deeper, more conventional potentials fitted the data without any need for renormalization. Data on the same reactions taken earlier at 56 MeV were reanalyzed and the results compared to the present experiment. The use of the distorted-waves approximation is examined critically.

39221 Energy dependence of the local optical potential for neutron-nucleus scattering. Delaroche, J.P.; Guss, P.P.; Honore, G.M.; Howell, C.R.; Walter, R.L.; Larson, D.C.; Hetrick, D.M.; Harvey, J.A. (Duke University and Triangle Universities Nuclear Laboratory, Durham, NC 27706). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 310-311(20 Jan 1985). (CONF-840945—). Contract AC05-76ER01067.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

A systematic study of the energy dependence of the local neutron optical potential up to 80 MeV has been performed using coupled channels analyses of a large set of neutron scattering and reaction observables.

39222 Neutron, alpha and total widths and spin assignments for resonances in ^{33}S+n from 10—400 keV. Coddens, G.P.; Salah, M.; Harvey, J.A.; Hill, N.W. (Universitaire Instelling Antwerpen, Antwerp, Belgium). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 302-303(20 Jan 1985). (CONF-840945—). Contract AC05-84OR21400.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

The S-33 neutron total cross section has been measured from 10 keV to 1 MeV. Resonance parameters (E/sub n/, Γ/sub n/, Γ/sub α/,J/sup π/) have been derived in the region from 10 keV to 400 keV.

39223 Scattering of polarized and unpolarized neutrons from ^{28}Si and ^{32}S. Howell, C.R. (Duke University and Triangle Universities Nuclear Laboratory, Durham, NC 27705). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 72-89(20 Jan 1985). (CONF-840945—). Contract AC05-76ER01067.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

The most complete set of differential cross sections $\sigma(\theta)$ and vector analyzing power A/sub y/(θ) for neutron scattering from ^{28}Si and ^{32}S over the 8 to 40 MeV energy range has been collected and evaluated. These data have been successfully described with the spherical optical model (SOM) and with phenomenological coupled-channels (CC) calculations. For the case of ^{28}Si, various calculations were performed to determine the sensitivity of the data and calculations to the sign of the potential deformation parameters β_2 and β_4. Comparisons of the present analyses to the corresponding analyses of proton-scattering data have yielded interesting results concerning the magnitudes of the Coulomb corrections to the OM potentials for ^{28}Si and ^{32}S.

39224 Optical models from low-energy s-, p- and d-wave cross sections. Johnson, C.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 446-462(20 Jan 1985). (CONF-840945—).

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

From transmission measurements with good resolution at low energies one can obtain data on the optical model potential (OMP) for individual partial waves by first making a multilevel analysis to isolate the partial waves and then averaging for comparison to the OMP. For each J/sup π/ the averaging yields two quantities which are related to the amplitude and phase of the OMP scattering function or, alternatively, to the volume integrals of the real and imaginary potentials. Historically, the experimental averages have been represented by the s- and p-wave strength functions, S_0 and S_1, and the s-wave scattering radius R'. To make full use of data from modern time-of-flight facilities such as ORELA it is necessary to re-examine the averaging procedure in order to extend it upward both in energy and neutron l-value. This averaging is discussed and applied to data on ^{30}Si, ^{32}S, ^{34}S, ^{40}Ca, ^{48}Ca, ^{60}Ni, ^{86}Kr and ^{208}Pb. The resulting OMP shows a systematic real potential with some indication of a parity dependence. The imaginary potential shows considerable fluctuations indicating the importance of nuclear structure at neutron energies below 1 MeV. A coupled channel OMP is also discussed for some of the nuclei.

6515 Nuclear Properties And Reactions, A=39-58, Theoretical

REFER ALSO TO CITATION(S) 39221

39225 **(CONF-860528—1) Evolution of nuclear shapes at high spins as determined by lifetime measurements.** Johnson, N. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011079.

From 8. annual symposium on safeguards and nuclear material management; Copenhagen, Denmark (13 May 1986).

Lifetime measurements of high spin states are obtained by the Doppler-shift recoil-distance method. Transition quadrupole moments are extracted from these data. Expanding on earlier experimental work, lifetime and moment of inertia measurements were made for ^{172}W. The data for transition quadrupole moments for the yrast states reveals an unexpected drop at high spin which can be explained by the simultaneous alignment of h/sub 9/2/ protons and i/sub 13/2/ neutrons. This conclusion is supported by moment of inertia measurements which show evidence of a 3-band crossing. 9 refs., 10 figs., 2 tabs. (DWL)

39226 **Half-life limit for ^{48}Ca($2\beta^-$)^{48}Ti(0_3^+,2997).** Alburger, D.E.; Cumming, J.B. (Brookhaven National Laboratory, Upton, New York 11973). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 6, 2169-2170(Jun 1986). Contract AC02-76CH00016.

Gamma-gamma coincidence data from a previous search for the decay sequence ^{48}Ca(β^-)^{48}Sc(β^-)^{48}Ti, in which a sample containing 3.71 g of ^{48}Ca was counted for 206 days in a HPGe(well-type)-NaI(Tl) detector combination, were reanalyzed to place a half-life limit on ^{48}Ca($2\beta^-$)^{48}Ti(0_3^+, 2997). The signature for this decay would be the detection of 2014-983-keV $\gamma\gamma$ coincidences. An ^{88}Y source was used to establish the $\gamma\gamma$ coincidence efficiency. A lower limit (95% confidence) of T/sub 1/2/>8 x 10^{18} yr was obtained for the partial half-life for the $2\beta^-$ decay of ^{48}Ca to the 2997-keV 0_3^+ level of ^{48}Ti.

39227 **Deep inelastic separated response functions from ^{40}Ca and ^{48}Ca.** Deady, M.; Williamson, C.F.; Zimmerman, P.D.; Altemus, R.; Whitney, R.R. (Department of Physics and Bates Linear Accelerator Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 6, 1897-1904(Jun 1986).

Deep inelastic scattering cross sections have been measured for ^{40}Ca and ^{48}Ca at electron energies between 100 and 375 MeV at scattering angles of 90° and 140°. Longitudinal and transverse response functions at three-momentum transfers between 250 and 410 MeV/c have been extracted using a Rosenbluth separation. The response functions are compared to calculations modeling the nucleus as a noninteracting relativistic Fermi gas. The model is found to agree with the observed transverse response function in the region of expected quasi-free nucleon knockout, but the model overestimates the observed longitudinal response. Comparisons of the response functions of the two isotopes are made, and differences between ^{40}Ca and ^{48}Ca are seen.

39228 **Polarization transfer and the spin-parity composition of the charge-exchange continuum.** Klein, A.; Love, W.G. (Department of Physics and Astronomy, The University of Georgia, Athens, Georgia 30602). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 6, 1920-1930(Jun 1986).

Measured and calculated transverse polarization coefficients are compared at 0° for the reactions ^{90}Zr(p,n), ^{48}Ca(p,n), and ^{40}Ca(p,n) at intermediate incident energies and at negative Q values up to ~50 MeV in an attempt to better understand the spin-parity composition of the charge-exchange continuum. Even at 0° the data indicate a significant amount of natural parity spin-flip strength, and this is supported by our calculations. We also present the predicted polarization transfer coefficient spectrum for the (p,n) reaction on ^{90}Zr at 500 MeV, whose measurement is anticipated in the near future.

39229 **Nuclear Data Sheets for A = 47.** Burrows, T.W. (National Nuclear Data Center, Brookhaven National Laboratory, Upton, NY 11973). *Nuclear Data Sheets;* **48**: No. 1, 1-110(May 1986). Contract AC02-76CH00016.

The 1977 evaluation of A = 47 (77Ha45) has been revised using experimental decay and reaction data received by the cutoff data noted below. See 75Be56 for calculations related to the unobserved nuclides, ^{47}Mn and ^{47}Fe.

39230 **Nuclear data sheets for A = 51.** Chunmei, Z.; Enchen, Z.; Xiane, L.; Junde, H. (Institute of Atomic Energy P. O. Box 275 (41), Beijing, China). *Nuclear Data Sheets;* **48**: No. 1, 111-244(May 1986).

The 1978 nuclear data sheets for A = 51 (78Au01) have been revised on the basis of experimental data available by the cutoff date noted below. The level schemes and decay schemes, and experimental data on which they are presented for all nuclei with mass number A = 51. The experimental data are evaluated; the inconsistencies and discrepancies are noted; and adopted values for levels and γ-ray energies, γ-ray intensities, as well as for the other nuclear properties are given.

39231 **Half life of sup(57)Ni.** Dickens, J.K. (Oak Ridge National Lab., TN, USA). *Journal of Radioanalytical and Nuclear Chemistry;* **103**: No. 5, 273-280(13 Feb 1986).

The half life of sup(57)Ni was measured by Ge(Li) γ-ray spectroscopy. The sup(57)Ni radionuclide was created by bremsstrahlung impinging a sample of elemental Ni. Time change of the activity of the 1377.6 keV γ-ray following decay of sup(57)Ni was analyzed to obtain a half life of 35.54 +- 0.05 h for sup(57)Ni. 8 refs.

39232 **Nuclear structure approach to the imaginary optical potential and inelastic form factor.** Osterfeld, F.; Madsen, V.A. (Institut fuer Kernphysik, KFA Juelich, D-5170 Juelich, West Germany). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 26-49(20 Jan 1985). (CONF-840945—). Contract AT06-79ER10405.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

Microscopic calculations of the second order imaginary optical potential are presented for neutron and proton scattering from spherical target nuclei using random phase approximation transition densities for intermediate excited states. Both inelastic and charge-exchange intermediate states are considered. The contribution of the deuteron channel to the absorption is estimated. The sensitivity of the surface absorption on details of the nuclear structure wave functions is discussed. Calculations are presented for the isoscalar term W_0 of the optical potential, the isovector term W_1 (Lane-term), and the Coulomb correction term ΔW/sub C/. Elastic scattering cross sections are calculated from the microscopic nonlocal potentials and are compared to cross sections which were obtained from the equivalent local potentials. The validity of the local approximation to the nonlocal potential is investigated. The differences and similarities between the nuclear matter approach and the nuclear structure approach to the calculation of the imaginary potential are discussed. The nuclear structure approach is also applied to the calculation of the imaginary inelastic form factor used in inelastic scattering. First results are presented for the ^{48}Ca(p,n)^{48}Sc(O$^+$,E/sub x/ = 6.8 MeV) reaction at an incident energy of 25 MeV.

39233 **d/sub 5/2/-single particle strength in ^{48}Ca+n.** Harvey, J.A.; Johnson, C.H.; Carlton, R.F.; Castel, B. (Oak Ridge National Laboratory, Oak Ridge, TN 37831). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 304-305(20 Jan 1985). (CONF-840945—). Contract AC05-84OR21400.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

The neutron total cross section of ^{48}Ca was measured up to 4 MeV and the data analyzed using an R-matrix code to obtain resonance parameters and potential scattering phase shifts. No s-wave resonances were observed and the small cross section (~0.5 b) at low energy requires a real well depth of 48 MeV. Three strong d-

wave resonances (amounting to 45% of the single particle limit) were found in the 0.8 to 2.0 MeV energy region. Shell-model-in-the-continuum calculations agree with these observations.

6516 Nuclear Properties And Reactions, A=59-89, Theoretical

39234 (UCRL—94158-Rev.1) Neutron capture cross sections for ^{86}Sr and ^{87}Sr at stellar temperatures. Revision 1. Bauer, R.W.; Mathews, G.J.; Becker, J.A.; Howe, R.E.; Ward, R.A. (Lawrence Livermore National Lab., CA (USA)). 25 Jun 1986. Contract W-7405-ENG-48. 4p. (CONF-860741—1-Rev.1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012354.

From International symposium on weak and electromagnetic interactions in nuclei; Heidelberg, F.R. Germany (1 Jul 1986).

Recent work on s-process nucleosynthesis has focused attention on the investigation of capture cross sections for nuclei in the mass region near the N = 50 closed neutron shell. Of special astrophysical interest are (i) the analysis of the s-process branching through ^{86}Kr as a monitor of stellar neutron density and temperature and (ii) the investigation of the possible chronometric pair ^{87}Rb-^{87}Sr as an independent measure of the age of the galaxy. For both problems the capture cross sections of the two pure s-process nuclei ^{86}Sr and ^{87}Sr have to be known to an accuracy of 5% or better. The current investigation of the neutron capture cross sections for ^{86}Sr and ^{87}Sr was undertaken to extend recent measurements by Walter and Beer to energies below 3.5 keV, where strong resonances are known to exist, and to explore the discrepancy in the results of the Maxwellian averaged capture cross section of ^{87}Sr at kT = 30 keV as reported by previous investigators. 9 refs., 1 fig.

39235 Electroexcitation of giant multipole resonances in ^{63}Cu. Kawazoe, Y.; Miyase, H.; Tsubota, H.; Yokokawa, J.; Oyamada, M.; Torizuka, Y. (Education Center for Information Processing, Tohoku University, Kawauchi, 980 Sendai, Japan). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 1917-1919(Jun 1986).

Giant multipole resonances in ^{63}Cu were investigated by inelastic electron scattering. From a model-dependent analysis assuming resonant parts expressed as a sum of Breit-Wigner shapes and a smooth background, the centroid excitation energies, the widths, and the sum rule depletions were deduced and compared with the results on neighboring isotones. Our results were in excellent agreement with photoreaction data.

39236 Half-life of ^{80}Zn: The first measurement for an r-process waiting-point nucleus. Gill, R.L.; Casten, R.F.; Warner, D.D.; Piotrowski, A.; Mach, H.; Hill, J.C.; Wohn, F.K.; Winger, J.A.; Moreh, R. (Brookhaven National Laboratory, Upton, New York 11973). *Physical Review Letters;* **56**: No. 17, 1874-1877(28 Apr 1986). Contract AC02-76CH00016;W-7405-ENG-82;AC02-79ER10493.

A half-life of 0.55 +- 0.02 s was measured for the neutron-rich fission-product nucleus $_{30}$^{80}Zn$_{50}$. A Q/sub β/ value for the decay of ^{80}Zn of 7.15 +- 0.15 MeV and a level scheme for ^{80}Ga have also been deduced. The properties of this N = 50 waiting-point nucleus are significant for the evaluation of different models of r-process environments and exposure times.

39237 Optical model scattering functions for low energy neutrons on ^{86}Kr. Carlton, R.R.; Harvey, J.A.; Johnson, C.H. (Middle Tennessee State University, Murfreesboro, TN 37312). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 308-309(20 Jan 1985). (CONF-840945—). Contract AC05-84OR21400;AS05-80ER10710.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

Optical scattering functions are deduced from an R-matrix analysis and subsequent averaging of high resolution ^{86}Kr+n transmission data. These functions have been fitted by adjusting the well depths in an optical model with r_0 = r/sub D/ = 1.21 fm, a_0 = 0.66 fm and a/sub D/ = 0.48 fm. The well depths are V_0 = 51.5 MeV and V/sub so/ = 5.5 MeV for l = 1 and V_0 = 48.5 for l = 0. W/sub D/ is about 3.5 MeV for s/sub 1/2/, p/sub 1/2/ and p/sub 3/2/. Each well depth has an uncertainty of about +- 1 MeV.

6517 Nuclear Properties And Reactions, A=90-149, Theoretical

39238 Search for superdeformation effects in ^{144}Gd. Vivien, J.P.; Nourreddine, A.; Beck, F.A.; Byrski, T.; Gehringer, C.; Haas, B.; Merdinger, J.C.; Radford, D.C.; Schutz, Y.; Dudek, J. (Centre de Recherches Nucleaires, 67037 Strasbourg Cedex, France). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 2007-2016(Jun 1986).

Quasicontinuum γ-decay studies of ^{144}Gd have been performed using the ^{120}Sn(^{28}Si, 4n)reaction at 125, 135, 145, and 155 MeV bombarding energies. Angular distribution and multiplicity measurements have been done at the above energies. At 145 MeV bombarding energy, a lifetime measurement has also been performed. Although a collective behavior has been observed, the present data do not give evidence for population of superdeformed rotational bands. Theoretical interpretation using the cranking model with the Woods-Saxon field is given. The effects of temperature and pairing on the superdeformed configuration are discussed; superdeformation effects are predicted to disappear below I~60—70 h when temperature exceeds ~500 keV.

39239 Inelastic proton excitation of high-lying giant resonances. Adams, G.S.; Carey, T.A.; McClelland, J.B.; Moss, J.M.; Seestrom-Morris, S.J.; Cook, D. (Physics Department, University of South Carolina, Columbia, South Carolina 29208). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 2054-2058(Jun 1986).

Inelastic scattering of 800 MeV protons has been studied for targets of ^{208}Pb, ^{144}Sm, and ^{118}Sn. At excitation energies above particle emission threshold a spectrum of giant resonances is clearly in evidence. Angular distributions were extracted for the high-lying peaks (~20 MeV excitation energy) in ^{208}Pb and ^{144}Sm. Collective model distorted-wave Born approximation analyses of these data show that isoscalar octupole and dipole states dominate the spectra.

39240 Nuclear reactions of silver with 0.8-TeV protons. Wang, C.F.; Porile, N.T. (Department of Chemistry, Purdue University, West Lafayette, Indiana 47907). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 2183-2184(Jun 1986).

Cross sections for the formation of radionuclides in the interaction of silver with 0.8 TeV protons have been measured. The results are compared with previously reported data obtained for 300 GeV protons. The ratios of cross sections at the two energies are consistent with unity and are independent of product mass number between A = 7 and 105.

39241 Observations of 'pairing-free' K/sup π/=1$^+$ rotational bands in deformed odd-odd A approx. equal to 100 nuclei. Peker, L.K.; Wohn, F.K.; Hill, J.C.; Petry, R.F. (Brookhaven National Lab., Upton, NY, USA; Ames Lab., IA, USA; Oklahoma Univ., Norman, USA). *Physics Letters* [*Section*] *B;* **169**: No. 4, 323-326(3 Apr 1986).

Rotational bands with K/sup π/=1$^+$ in the odd-odd nuclei $_{39}$/sup 100,102/Y and $_{41}$/sup 102,104/Nb are postulated from β^- decay of their even-even parents. Each two-quasiparticle band has a moment of inertia very close to that of a rigid spheroidal nucleus with deformation β proportional 0.3, hence these bands are nearly 'pairing free'. (orig.).

6518 Nuclear Properties And Reactions, A=150-189, Theoretical

REFER ALSO TO CITATION(S) 39256

39242 Characterization of isomers in ^{155}Ho. Sood, P.C.; Hoff, R.W.; Sheline, R.K. (Department of Physics, Banaras Hindu University, Varanasi 221005, India; Nuclear Chemistry Division, Lawrence Livermore National Laboratory, Livermore, California 94550). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 2163-2168(Jun 1986).

The experimentally known isomers of ^{158}Ho have been characterized by estimating the energies of two-quasiparticle excitations. Included in this modeling is the effect of a residual n-p interaction. A 21-min isomer is assigned the configuration K/sup π/ = 9$^+$ {(7/2)$^-$ [523up-arrow] /sub p/ + (11/2)$^-$ [505up-arrow]/sub n/} and is predicted to lie 180 keV above the 5$^+$ ground state. The antiparallel K/sup π/ = 2$^+$ state of this configuration is assigned to an observed level at 316 keV. The 21-min isomer decays by an allowed unhindered transition to a 2528-keV level in ^{158}Dy for which we confirm the two-quasineutron configuration K/sup π/ = 8$^+$ {(5/2)$^-$ [523arrow-down] /sub n/ + (11/2)$^-$ [505up-arrow]/sub n/}. A 27-min 2$^-$ isomer at 67.3 keV and a 29-ns 5$^-$ isomer at 156.9 keV are assigned the configuration {(7/2)$^+$ [404arrow-down]/sub p/ minus-or-plus(3/2)$^-$ [521up-arrow]/sub n/}. A 1.85-ns 1$^-$ isomer at 139.2 keV is assigned the configuration {(5/2)$^+$ [402up-arrow]/sub p/ + (3/2)$^-$ [521up-arrow]/sub n/} and the K/sup π/ = 4$^-$ member of this Gallagher-Moszkowski pair is predicted to occur at 70 keV. Specific experiments are suggested to verify these predictions.

30243 Inelastic electron scattering from collective levels of ^{154}Gd. Hersman, F.W.; Bertozzi, W.; Buti, T.N.; Finn, J.M.; Hyde-Wright, C.E.; Hynes, M.V.; Kelly, J.; Kovash, M.A.; Kowalski, S.; Lichtenstadt, J. (Department of Physics, University of New Hampshire, Durham, New Hampshire 03824). *Physical Review [Section] C: Nuclear Physics;* 33: No. 6, 1905-1916(Jun 1986). Contract AC02-76ER03069.

Differential cross sections for elastic and inelastic scattering of electrons by ^{154}Gd have been measured for states below 1 MeV of excitation. Levels of three major collective bands are studied: the 0$^+$, 2$^+$, 4$^+$, and 6$^+$ rotational states; the 2$^+$ gamma vibration; and the 0$^+$ and 2$^+$ beta vibrational levels. This study includes the first electron scattering measurements of a beta vibration. Extraction of these small inelastic cross sections required improvements in momentum resolution and detector response uniformity. Data from the rotational band are compared with axially symmetric Hartree-Fock predictions. Disagreement between the measurements and Legendre projections of the calculated density, particularly for higher multipolarity states, indicates a breakdown in the Hartree-Fock approximation or the rotational model. Small amplitude vibrations of the nuclear shape derived from the measured rotational densities agree well in shape when independently normalized to the cross section strength for both the beta and gamma 2$^+$ vibrations, substantiating their geometrical interpretations. Once transition strength of the beta band is set, however, the strength and shape of the 0$^+$ beta is not correctly predicted, indicating a more complicated configuration.

30244 Evolving collectivity at high spins in ^{157}Er, ^{158}Er, and ^{159}Er. Oshima, M.; Johnson, N.R.; McGowan, F.K.; Baktash, C.; Lee, I.Y.; Schutz, Y.; Ribas, R.V.; Wells, J.C. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] C: Nuclear Physics;* 33: No. 6, 1988-1998(Jun 1986). Contract AC05-84OR21400.

Lifetimes of high-spin states in /sup 157,158,159/Er have been measured following the reaction ^{128}Te(^{34}S,xn) induced by 155-MeV ^{34}S ions. A Doppler-shift recoil-distance device was used and γ-γ coincidences were recorded between five germanium detectors at 90° to the beam direction and a Compton-suppressed Ge detector at 0° to record the shifted and unshifted γ-ray peaks. The results for the ground band of ^{158}Er clearly show increasing collectivity with spin, an effect probably arising from centrifugal stretching for this N = 90 nucleus. In the a band, formed by the alignment of a pair of i/sub 13/2/ neutrons, there is a significant reduction in the collectivity, which appears to have a rotational-frequency dependence similar to that found earlier for ^{160}Yb and interpreted as possibly arising from movement toward triaxiality in the nuclear shape. Four states each in the yrast bands of ^{157}Er and ^{159}Er were also measured, and here, too, a similar reduction of collectivity at higher rotational frequencies is observed.

6519 Nuclear Properties And Reactions, A=190-219, Theoretical

30245 (CONF-860575—6) Multipole matrix elements for ^{208}Pb. McDaniels, D.K.; Lisantti, J.; Swenson, L.W.; Chen, X.Y.; Bertrand, F.E.; Gross, E.E.; Horen, D.J.; Glover, C.; Haeusser, O.; Hicks, K. (Oregon Univ., Eugene (USA); Oregon State Univ., Corvallis (USA); Oak Ridge National Lab., TN (USA); Simon Fraser Univ., Burnaby, British Columbia (Canada)). 1986. Contract AC05-84OR21400. 3p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011978.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

New measurements of inelastic proton scattering to low-lying states of ^{208}Pb at 200 and 400 MeV are reported. Deformation lengths extracted from angular distributions for the 3$^-$ (2.614 MeV), 5_1^- (3.198 MeV), 5_2^- (3.209 MeV), 2$^+$ (4.086 MeV) and 4$^+$ (4.324 MeV) states are in good accord with values extracted at other incident proton energies. The fact that the deformation lengths are independent of incident proton energy within experimental uncertainty provides support for the validity of the collective DWBA for medium energy proton scattering to strongly excited states. Advantage is taken of this to extract statistically more precise values of the ratio of neutron to proton multipole matrix elements (M/sub n//M/sub p/). Different methods of determining the appropriate average value of M/sub n//M/sub p/ are discussed. 3 refs., 1 tab.

30246 (CONF-860741—5) Photon decay of giant resonances. Bertrand, F.E.; Beene, J.R.; Halbert, M.L. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012233.

From International symposium on weak and electromagnetic interactions in nuclei; Heidelberg, F.R. Germany (1 Jul 1986).

The total gamma-decay probability, the ground-state gamma branching ratio, and the branching ratios to a number of low-lying states as a function of excitation energy have been determined in ^{208}Pb to approximately 15 MeV. The total yield of ground-state E2 gamma radiation in ^{208}Pb can only be understood if decay of compound states is considered. Other observations in ^{208}Pb include the absence of a significant branch from the giant quadrupole resonance (GQR) to the low-lying collective states at 2.6 MeV and 4.08 MeV, and a strong branch to a 3$^-$ state at 4.97 MeV. 20 refs., 6 figs., 1 tab.

30247 (HMI-P—6/85-Prepr.) Spectroscopy and measurement of electromagnetic moments in sup(198,200,210)Po. Maier, K.H. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.)). 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752084.

The quadrupole coupling constants for the ^{210}Po Isup(π)=8$^+$, 11$^-$, 13$^-$ isomers in Bi have been measured, and Q(11$^-$)=82(2) fm^2 and Q(13$^-$)=90(2) fm^2 normalized to Q(^{210}Po8$^+$)=57 fm^2 are deduced. In beam γ-spectroscopy of sup(198,) ^{200}Po showed the (πh^{2}sub(9/2) 8$^+$) π(hsub(9/2)isub(13/2) 11$^-$) and (visub(13/2) 12$^+$) isomers. The B(E2 8$^+$->6$^+$) and Q(8$^+$) in ^{198}Po to ^{210}Po are discussed, a sudden drop is found for the B(E2) in ^{198}Po. The B(E3, 11$^-$->8$^+$) rises very steeply in the light Po isotopes. (orig.).

30248 Relativistic effects on spin observables in quasielastic proton scattering. Horowitz, C.J.; Iqbal, M.J. (Laboratory for Nuclear Science and Department of Physics, Center for Theoretical Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Physical Review [Section] C: Nuclear Physics;* 33: No. 6, 2059-2069(Jun 1986). Contract AC02-76ER03069.

The spin observables in quasielastic proton scattering are calculated in a simple relativistic model where the NN interaction is assumed to depend on the enhancement of the lower components of nucleon wave functions (because of strong nuclear potentials). This enhancement is characterized by an average effective mass M(of (0.8—0.9)M which is calculated in an eikonal model. The M(de-

pendence of the NN interaction is taken from relativistic impulse approximation calculations. The polarization is found to decrease by 40 percent compared to the free NN value at 500 MeV. Next, simple formulas are provided to estimate the effects of spin-orbit potential distortions on spin observables. At 500 MeV and 18.5° in ^{208}Pb, the polarization is decreased by 5 percent while D/sub l/'l and D/sub s/'s are decreased by 15 percent and D/sub n/n is almost unchanged.

39249 Cross section and analyzing power measurements for the giant resonance region in ^{208}Pb with 200-MeV protons. McDaniels, D.K.; Tinsley, J.R.; Lisantti, J.; Drake, D.M.; Bergqvist, I.; Swenson, L.W.; Bertrand, F.E.; Gross, E.E.; Horen, D.J.; Sjoreen, T.P. (University of Oregon, Eugene, Oregon 97403). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 1943-1954(Jun 1986).

The giant resonance region in ^{208}Pb has been studied using inelastic scattering of 200-MeV polarized and unpolarized protons. Both differential cross sections σ(theta) and analyzing power A/sub y/(theta) measurements were made. The isoscalar giant quadrupole resonance at 10.6 +- 0.5 MeV, and the combined isovector giant dipole resonance and isoscalar giant monopole resonance at 14.0 +- 0.6 MeV are clearly observed. Within uncertainties all three giant resonances are in accord with full energy-weighted sum rule depletions, based on comparisons with macroscopic distorted wave Born approximation calculations. Data for a peak at 20.9 +- 1.0 MeV are found to be consistent with an isoscalar giant octupole resonance exhausting 36 +- 12 % of the energy-weighted sum rule strength. A peak located at an excitation energy of 12.0 +- 0.7 MeV is shown to be a 2hω, L = 4 transition depleting 8 +- 3 % of the hexadecapole energy-weighted sum rule strength. The measured reduced transition probability for the 3$^-$ state at 2.614 MeV is consistent both with the accepted value and with results measured at 334 and 800 MeV. Our results for the 3$^-$ state at 2.614 MeV and for the giant quadrupole resonance do not support the anomalous behavior found in earlier studies at 104, 156, and 201 MeV. This shows that the macroscopic distorted wave Born approximation can be used to extract deformation lengths providing meaningful comparison with electromagnetic energy-weighted sum rules for proton inelastic scattering to at least 800 MeV incident proton energy.

39250 Fusion, transfer, and elastic scattering at sub-barrier energies for /sup 16,18/O ions on ^{208}Pb and ^{15}N and ^{16}O ions on ^{209}Bi. Vulgaris, E.; Grodzins, L.; Steadman, S.G.; Ledoux, R. (Laboratory for Nuclear Science and Physics Department, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 2017-2027(Jun 1986). Contract AC02-76ER03069.

The fusion of the heavy asymmetric systems of ^{16}O, ^{18}O+ ^{208}Pb and ^{15}N, ^{16}O+ ^{209}Bi was studied at bombarding energies near and below the Coulomb barrier. The fusion-fission, transfer, and elastic angular distributions were measured for all four systems. The evaporation residue component of the fusion was measured for only the ^{16}O+ ^{208}Pb→ ^{224}Th reaction; in agreement with statistical model calculations, the cross section for the evaporation residues was found to be negligible compared to the fission, and hence can be ignored in all the systems. The shapes of the fission fragment angular distributions are then a direct measure of the entrance channel spins which lead to fusion. The experimental sub-barrier fusion cross sections are underpredicted by the one-dimensional barrier penetration model in all cases. However, if the zero point motion of the targets is included in the barrier penetration model, the energy dependence of both the total fusion and the fission angular distributions can be explained for the ^{15}N+ ^{209}Bi system alone. To fit the low-energy fusion of the oxygen reactions requires considerably more zero point motion: this being inconsistent with the fact that this effect should be the same in all the reactions. Also, the cross sections measured for the transfer channels were found to exhibit the same trend as the fusion at the lower energies. This correlation suggests that some of the sub-barrier fusion in the oxygen-induced reactions may be due to transfer-related processes.

39251 Phenomenological mapping of the Fermi-surface anomaly with neutron-nucleus collisions. Finlay, R.W.; Annand, J.R.M.; Petler, J.S.; Dietrich, F.S. (Ohio University). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 322-323(20 Jan 1985). (CONF-840945—).

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

Elastic and inelastic neutron scattering data from ^{208}Pb and ^{209}Bi are analyzed.

6520 Nuclear Properties And Reactions, A=220 And Above, Theoretical

REFER ALSO TO CITATION(S) 38783, 39257

39252 (GSI—85-64-Prepr.) Sub-Coulomb transfer in ^{238}U+ ^{238}U collisions. Wirth, G.; Bruechle, W.; Bruegger, M.; Fan, W.; Suemmerer, K.; Funke, F.; Kratz, V.; Lerch, M.; Trautmann, N. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.); Mainz Univ. (Germany, F.R.). Inst. fuer Kernchemie). Dec 1985. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752079.

We report the excitation function and angular distributions for the one-neutron transfer product ^{239}U in the heavy-ion reaction ^{238}U + ^{238}U near and far below the Coulomb barrier. Remarkable deviations from semi-classical expectations are seen for the central collisions. Neither absorption nor transfer fission seem to be adequate explanations. It remains open whether the observed shape of the angular distributions supports the idea of a potential pocket in ^{238}U + ^{238}U collisions or if it is a more general characteristic for sub-Coulomb transfer in very heavy ion reactions. (orig.).

39253 (LBL—21385) Leap to explore the region of neutron-rich heavy element isotopes. Hoffman, D.C. (Lawrence Berkeley Lab., CA (USA)). Oct 1985. Contract AC03-76SF00098. 13p. (CONF-8510318—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011305.

From Symposium in honor of Professor A. Pappas; Oslo, Norway (24 Oct 1985).

The research aims of the Large Einsteinium Activation Program (LEAP) are described. This program is a major initiative to exploit currently existing expertise in heavy element research and the potential for producing very heavy actinide target materials such as 285-day ^{254}Es at the High Flux Isotope Reactor at Oak Ridge National Laboratory. The stated aims of the program are to produce heavy element isotopes, to conduct chemical studies of these isotopes, to study the nuclear properties of such isotopes, and to produce a superheavy element (183 neutrons) by the using a ^{254}Es target and ^{48}Ca projectiles. 13 refs., 2 figs., 2 tabs. (DWL)

39254 Production of cold target-like fragments in the reaction of ^{48}Ca+ ^{248}Cm. Gaeggeler, H.; Bruechle, W.; Bruegger, M.; Schaedel, M.; Suemmerer, K.; Wirth, G.; Kratz, J.V.; Lerch, M.; Blaich, T.; Herrmann, G. (Gesellschaft fuer Schwerionenforschung, D-6100 Darmstadt, Federal Republic of Germany). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 6, 1983-1987(Jun 1986).

Yields for isotopes of Rn through Pu have been measured in the reaction ^{48}Ca+ ^{248}Cm at an energy of 248—263 MeV (1.04—1.10 times the Coulomb barrier). Despite the low bombarding energy, high and essentially constant integral yields of about 1 to 2 mb for the elements Rn through U were observed. There is evidence that these nuclides are produced with little excitation energy.

39255 International program to improve decay data for transactinium nuclides. Helmer, R.G.; Reich, C.W. (Idaho National Engineering Lab., Idaho Falls, USA). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **242**: No. 3, 475-479(15 Jan 1986). (CONF-850533—).

From 6. symposium on X- and gamma-ray sources and applications; Ann Arbor, MI, USA (21 May 1985).

Also published as report EGG-M--08085; CONF-850533--4.

To help meet an identified need for precise decay data, in 1977 the IAEA organized an international Coordinated Research Program (CRP) to measure and evaluate half-lives and γ- and α-emission probabilities for selected transactinium nuclides of importance for reactor technology. The CRP goals were (1) to determine a list of data that needed improvement, (2) to encourage new measurements, and (3) to evaluate the available data. All three phases of this work are now complete. Our participation in this effort has involved the measurement of γ-ray emission probabilities for sup(232,233,235)U, sup(238,239,240,241)Pu, ^{230}Th and ^{231}Pa, as well as participating in the data evaluation. The γ-emission probabilities were determined from the measurement of γ-emission rates with the goal of obtaining uncertainties of <=1%. γ-measurements were made on calibrated Ge detectors. These calibrations were done by standard methods, generally involving measurements at proportional60 γ-ray energies from 14 to 2700 keV. The efficiency-calibration functions were assigned uncertainties ranging from 2% below 50 keV to 0.50% from 400 to 1400 keV. The determination of the decay rates of the various sources involved several techniques. The ^{239}Pu, ^{238}Pu and ^{240}Pu samples were calibrated by gross α-emission-rate measurements at NBS. The ^{235}U sample was taken from an NBS-calibrated spike solution. The ^{241}Pu and ^{233}U samples were calibrated by isotope-dilution mass spectrometry based on spikes of the calibrated ^{239}Pu, ^{240}Pu and ^{235}U materials. Some of our results are given, together with a comparison of some present and previous results.

6530 Nuclear Theory

39256 (CONF-860575—4) Interacting Boson Model: selected recent developments. Balantekin, A.B. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 7p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011769.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

The Interacting Boson Model is briefly reviewed. Recent applications of this model to the low-lying collective magnetic-dipole excitations and to the spectra of ^{196}Ir are described. 13 refs., 3 figs.

39257 (CONF-8604165—5) Fission process from saddle to scission: a phenomenological perspective. Wilkins, B.D.; Gindler, J.E. (Argonne National Lab., IL (USA)). 1986. Contract W-31109-ENG-38. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012113.

From International conference on heavy ion physics; Rochester, NY, USA (21 Apr 1986).

The pre-scission kinetic energy and dissipation energy deduced from physical measurements for the fission of ^{230}U are found to be reasonable and consistent with the potential energy difference between the saddle and scission points provided scission is assumed to occur with a finite neck radius of ~2 fm. A nearly linear correlation is observed between the proton odd-even effect in fission and the sum of the excitation energy at the saddle point plus the dissipation energy. Prescission kinetic energies deduced by two methods are shown to agree reasonably well with those calculated with a wall-and-window type dissipation mechanism.

39258 (CONF-8606130—1) Dynamical symmetries for odd-odd nuclei. Balantekin, A.B. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011770.

From International conference on nuclear structure, reactions, and symmetries; Dubrovnik, Yugoslavia (5 Jun 1986).

Recent work for developing dynamical symmetries and supersymmetries is reviewed. An accurate description of odd-odd nuclei requires inclusion of the fermion-fermion force (the residual interaction) and the distinguishing of fermion configurations which are particle like and those which are hole like. A parabolic dependence of the proton-neutron multiplet in odd-odd nuclei is demonstrated. It is shown that a group structure for Bose-Fermi symmetries can be embedded in a supergroup. These methods are used to predict level schemes for Au-196 and Au-198. 11 refs., 3 figs.

39259 (GSI—85-67-Prepr.) Percolation in finite space. A picture of nuclear fragmentation. Biro, T.S.; Knoll, J.; Richert, J. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)). Dec 1985. 28p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752077.

The statistical aspects of cluster distributions as a decisive factor in high energy nuclear fragmentation are studied on a finite lattice model. The qualitative behaviour of the mass spectra is understood in terms of a simple model in which finite space constraints play the main role. Both, the light and the heavy mass sector of the spectrum are derived analytically. In the low density regime the model includes those results of Fisher's condensation theory which are frequently applied to nuclear fragmentation. (orig.).

39260 (GSI—85-69-Prepr.) Monoenergetic positron conversion in heavy ion fragments. Schlueter, P.; Soff, G.; Greiner, W. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.); Frankfurt Univ. (Germany, F.R.). Inst. fuer Theoretische Physik). Dec 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752078.

Conversion processes in light nuclei with transition energies above the e^+,e^--pair creation threshold are investigated within an analytical framework. In particular we evaluate the ratio of electron transition probabilities from the negative energy continuum into the atomic K-shell and into the positive energy continuum, respectively. The possible role of monoenergetic positron conversion with respect to the striking peak structures observed in e^+-spectra from very heavy collision systems is examined. (orig.).

39261 (GSI—86-9-Prepr.) Hard photon emission from colliding nuclei. Grosse, E.; Grimm, P.; Heckwolf, H.; Mueller, W.F.J.; Noll, H.; Oskarsson, A.; Stelzer, H.; Roesch, W. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.); Technische Hochschule Darmstadt (Germany, F.R.)). Mar 1986. 16p. NTIS, PC E02; Available from NTIS as TIB/B86-06551.

Direct photon emission observed in nucleus-nucleus collisions at intermediate beam energies ($0.3<=\beta<=0.4$) shows some very interesting features, especially when comparing it to pion production in such collisions. Valuable information is gained through the fit of a standard black body radiation formula to the data as well as by a comparison to classical bremsstrahlung theory. A photon production in the early phase of the collision is indicated; in the bremsstrahlung picture this corresponds to a rather sudden slowing down of the relative motion. (orig.).

39262 (LA-UR—86-2217) Nuclear-like states of quark matter. Goldman, T.; Schmidt, K.E.; Stephenson, G.J. Jr. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 4p. (CONF-860575—10). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012431.

From 2. conference on particle and nuclear physics; Lake Louise, Canada (26 May 1986).

In a world with only one flavor of light quark, QCD suggests that the low energy states of quark matter are similar to nuclei, but are not well represented as collections of baryons. Except for the existence of open nucleon channels, the same would be true for the actual, two-light-flavor world. 3 refs.

39263 Few channel models of nuclear reactions: Proton and deuteron elastic scattering expansions. Kozack, R.; Levin, F.S. (Physics Department, Brown University, Providence, Rhode Island 02912). *Physical Review [Section] C: Nuclear Physics;* 33: No. 6, 1865-1875(Jun 1986). Contract AC02-76ER03235.

In this paper, an asymmetric, antisymmetrized optical potential formalism is used to derive the low-order terms in multiple-scattering-type expansions for nonrelativistic proton-nucleus and deuteron-nucleus elastic scattering. In particular, the extended Faddeev theory of N-particle collisions is used to obtain the properly symmetrized, two-particle and three-particle contributions in these two cases, where it has been assumed that all potentials are pair interactions. The main purpose underlying the research reported

herein has been to prove that standard results can be obtained from an asymmetric formalism. For the two-particle contributions, the usual t/sup A/rho-type expression is obtained, where t/sup A/ is an antisymmetrized, two-particle transition operator. At this level of approximation, the results for the (d,d) case are the same as for the usual folding model. The three-particle contributions in the nucleon-nucleus case are identical to those of Picklesimer and Thaler, thus further demonstrating that standard results are contained in the asymmetric approach. The antisymmetrized, three-particle contributions to the (d,d) optical potential do not seem to have been previously derived; they are the obvious analog of the nucleon-nucleus results, and are physically reasonable in form. However, at this level of approximation, the (d,d) description is no longer found to be that of a folding model.

39264 **Few channel models of nuclear reactions: Distorted-wave Born approximation for light-ion-induced transfer processes.** Kozack, R.; Levin, F.S. (Physics Department, Brown University, Providence, Rhode Island 02912). *Physical Review [Section] C: Nuclear Physics;* 33: No. 6, 1876-1887(Jun 1986). Contract AC02-76ER03235.

Standard derivations of the distorted wave Born approximation amplitudes for particle-transfer reactions have always left unanswered two fundamental questions: How can one justify cancellation of the typical, one-body, absorptive-potential counter term, and, which Pauli-principle exchange amplitudes correspond to the standard, nonexchange distorted-wave Born approximation amplitude? This paper provides an answer to these questions. This is accomplished by using a particular type of antisymmetrized, N-particle collision theory to describe the transfer processes. For the reaction (b,a), with the mass of a greater than the mass of b, the extended Faddeev theory of the preceding paper is used, while its time-reversal partner, the precursor form of the Bencze-Redish-Sloan equations, is used for the (a,b) case. They lead to almost identical first-order amplitudes. For all the reactions studied herein, it is found that the form of the nonexchange distorted-wave amplitudes: those that are commonly referred to as distorted-wave Born approximation amplitudes: are essentially the same as are used to fit data. This result is achieved without any need to account for cancellation of a counter term, since none appears, implying an absence of so-called core-excitation effects in first order.

39265 **Heavy ion peripheral collisions at relativistic energies: Theory of giant quadrupole excitation.** Rasmussen, J.O.; Canto, L.F.; Qiu, X. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review [Section] C: Nuclear Physics;* 33: No. 6, 2033-2038(Jun 1986). Contract AC03-76SF00098.

The theory of excitation of the giant quadrupole resonance in E/Q = 0.5—2.1 GeV heavy ion collisions is studied. Karol's soft spheres model based on nucleon-nucleon cross sections is generalized to deal with collective excitations in deformed nuclei. The giant quadrupole resonance cross sections are calculated in several cases. The results are shown to be in close agreement with the prediction of Blair's simple diffraction model except for excitation in the light nuclei ^{12}C and ^{16}O. Comparison with ^{16}O fragmentation yield data is made.

39266 **Application of a hot spot model to fragment emission from pion true absorption.** Loveman, R.A. (Nuclear Physics Laboratory, University of Colorado, Boulder, Colorado 80309). *Physical Review [Section] C: Nuclear Physics;* 33: No. 6, 2209-2211(Jun 1986).

This paper describes the application of a "hot spot" statistical model to the process of pion-induced fragmentation. In other reactions the spectra of pre-equilibrium particles are well described by the evaporation of particles from highly excited subsystems evolving within a cold nuclear system. The model is found to be very successful at describing both the ^3He and ^4He spectra from 160 MeV positive pion absorption on silver and is the first successful application of a statistical model to pion-induced emission of complex particles. The implications this has for the process of pion true aborption are examined.

39267 **Macroscopic model of rotating nuclei.** Sierk, A.J. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830; Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review [Section] C: Nuclear Physics;* 33: No. 6, 2039-2053(Jun 1986).

I present a macroscopic model for the energy of rotating nuclei which has several refinements relative to the rotating-liquid-drop model. Of most importance are the inclusion of finite-range effects in the nuclear surface energy by means of a Yukawa-plus-exponential potential, finite surface diffuseness effects in the Coulomb energy and in the rotational moments of inertia, and an improved specification of nuclear shapes. With this model I calculate the properties of points of equilibrium corresponding to nuclear ground states and fission saddle points. The results are qualitatively similar to those of the rotating-liquid-drop model, but there are significant quantitative differences in fission-barrier heights and moments of inertia. Fission barriers for nonrotating nuclei are calculated for nuclei with atomic numbers varying from 14 to 117. For rotating nuclei, detailed results are given for the entire range of angular momentum for which a fission barrier exists, for nuclei with atomic numbers from 20 to 100, and for mass numbers which exceed the range of known nuclei. The calculated barriers are lower than liquid-drop-model barriers for lighter nuclei and are consistent with those deduced from experimental fission-fusion data over a wide range of nuclear species. The present calculations indicate that super-deformed rotating ground states, which are predicted in the liquid-drop model, would not survive fission long enough to undergo electromagnetic decay. Multiparameter functions which approximately reproduce the calculated results for barrier heights and moments of inertia are described.

39268 **Atoms, radiation and radiation protection.** Turner, J.E. Elmsford, NY; Pergamon Press (1986). 500p. Pergamon Press, Fairview Park, Elmsford, NY 10523.

This text describes basic atomic and nuclear structure as well as the physical processes that result in the emission of ionizing radiation. In addition, external and internal radiation protection criteria, standards and practices are presented from the standpoint of their underlying physical and biological basis. Contents: About atomic physics and radiation. Atomic structure and radiation. The nucleus and nuclear radiation. Interaction of heavy charged particles with matter. Interaction of beta particles with matter. Phenomena associated with charged particle tracks. Interaction of photons with matter. Neutrons, fission, and criticality. Radiation detection methods. Radiation dosimetry. Chemical and biological effects of radiation. Radiation protection criteria and standards. External radiation protection. Internal radiation protection.

39269 **Isospin effects in nuclear vibrations.** Madsen, V.A.; Brown, V.R. (Oregon State University, Corvallis, OR 97331). *AIP (American Institute of Physics) Conference Proceedings;* 124: No. 1, 171-182(20 Jan 1985). (CONF-840945—). Contract W-7405-ENG-48.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

A review of the evidence that the ratio of neutron and proton multiple matrix elements for collective vibrations in single-closed-shell nuclei differ systematically from N/Z is presented. A theoretical framework is given for understanding the data on the basis of the ideas of core polarization. It follows that nuclear deformation parameters are probe dependent and that analysis of excitations by two different probes such as (p,n') and (n,n') can, in principle, give the ratio M/sub n//M/sub p/. Application is made to first 2^+ states of open shell nuclei. Trends of M/sub n//M/sub p/ for higher 2^+ states are presented. Expected systematics of M/sub n//M/sub p/ ratios for giant isoscalar quadrupole transitions are presented.

39270 **Tests of effective interactions for nucleon scattering and charge exchange below 60 MeV.** Dietrich, F.S.; Petrovich, F. (Lawrence Livermore National Laboratory, Livermore, California 94550). *AIP (American Institute of Physics) Conference Proceedings;* 124: No. 1, 90-106(20 Jan 1985). (CONF-840945—). Contract W-7405-ENG-48.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

Significant progress has been made over the past several years in developing energy- and density-dependent effective interactions and optical potentials based on free nucleon-nucleon potentials. This leads to the hope that the nucleon-scattering reaction mechanism may be well enough known to probe details of nuclear spectroscopy (i.e., transition densities) more accurately than with purely phenomenological approaches. Of particular interest to this conference is the possibility of separating neutron and proton transition densities by comparing proton and neutron scattering, which can be done reliably only if the isovector parts of the effective interaction are well known. This paper attempts to assess the accuracy of presently available interactions through comparisons with elastic and inelastic scattering over a wide mass range, and also with the (p,n) isobaric-analog reaction. Particular emphasis has been placed on the isovector parts of the interaction and on Coulomb corrections by comparing proton and neutron scattering on the same targets. In a number of cases, precise neutron data have been measured to facilitate these comparisons.

39271 Parametric study of dynamic s-process neutron-capture nucleosyntheses: nuclear data needs. Mathews, G.J.; Howard, W.M.; Takahashi, K.; Ward, R.A. (Lawrence Livermore National Laboratory, Livermore, California 94550). *AIP (American Institute of Physics) Conference Proceedings;* **124**: No. 1, 511-514(20 Jan 1985). (CONF-840945—). Contract W-7405-ENG-48.

From Topical conference on neutron-nucleus collisions--a probe of nuclear structure; Glouster, OH, USA (5 Sep 1984).

We summarize the stellar parameters which characterize the s-process σN curve in the framework of models which produce an exponential distribution of exposures by periodic time-dependent neutron irradiations. The optimum parameter space, defined by the best fit to the solar-system σN curve, is distinctively different than the classical smooth monotonically decreasing curve. Constraints are placed on the s-process environment. The needs for better neutron-capture data in various mass regions are highlighted.

39272 Direct nuclear reactions. Glendenning, N.R. Orlando, FL; Academic Press Inc (1983). 392p. Academic Press, Inc., Orlando, Florida 32887.

This book is about the theory of direct nuclear reactions. It emphasizes the microscopic aspects of the reactions and their description in terms of the changes induced in the motions of the individual nucleons by the reaction. However, because collective motion can be accurately described by a few collective parameters. The goal of the book is thus to provide the novice with the means to become competent to do research in direct nuclear reactions and to provide the experienced researcher with a detailed discussion of the advanced topics. Topics covered include: coupled equations and the distorted-wave Born approximation; form factors and their nuclear structure centers; the basis of the optical potential as an effective interaction; reactions such as inelastic single- and two-nucleon transfer reactions; the effect of nuclear correlations; the role of multiple-step reactions; the theory of inelastic scattering and the relationship of the effective interaction to the free one; reactions between heavy ions; the polarizability of nuclear wave functions during a reaction; and the calculation of components of the optical potential arising from specific collective or transfer reactions.

6540 Radiation And Shielding Physics

REFER ALSO TO CITATION(S) 38586, 38739

39273 (INDC(CPR)—003/L) Measurement of nonelastic cross section for the elements Cu, Si at 14.9 MeV. Bao Shanglian; Zhong Wenguang; Shi Zhaomin; Tang Guaoyou; Chen Jinxiang; Zhang Chonghou. (International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee). Aug 1985. 5p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701550.

Nonelastic scattering cross sections for Cu and Si at 14.9 MeV have been measured by using the sphere transmission technique. Corrections have been applied to the data with a simpler method, principally for elastic scattering energy loss and multiple scattering. The results have been compared with others.

39274 (NBS/SP—711, pp 143-148) Superthermal sources of ultra-cold neutrons (UCN). Golub, R. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen, Germany). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

UCN are usually produced from a source in which the neutrons are close to thermal equilibrium with some moderator material. In this paper we review the principles of two types of sources (superfluid Helium and surface film sources) in which this is not the case and which are capable of producing significantly higher UCN intensities than thermal-equilibrium sources. In addition we discuss a method for carrying out the search for a neutron edm directly in the Helium moderator and compare the super-thermal source with a particular type of thermal equilibrium source (Doppler shifter source). Use of these sources for producing continuous beams of UCN (e.g., for interferometers) is also described. 14 refs.

39275 (NBS/SP—711, pp 149-154) Production of slow neutrons using Doppler-shifting from a high-speed rotor and their application in fundamental research. Dombeck, T. (Los Alamos National Lab., NM). Feb 1986. NTIS, PC A08/MF A01. File Number DE86009521. (CONF-8511137—).

From Workshop on the investigation of fundamental interactions with cold neutrons; Gaithersburg, MD, USA (14 Nov 1985).

A high-speed rotor with a Bragg scattering crystal in operation at a pulsed spallation source has produced cold ($v < 30$ m/s) and ultracold neutrons ($v < 7$ m/s) with spatial densities near to those observed at the highest flux reactors. Prospects are discussed for even higher fluxes at the LANSCE facility being commissioned at Los Alamos. Though the rotor is naturally matched to pulsed sources, prospects for producing short bursts, or on the other hand, continuous beams of slow neutrons may have application at reactors as well. 14 refs., 1 fig.

39276 (STRATECH—3-1) Photon absorption graphs: 1 keV to 10 MeV. Bom, V.R.; Hollander, R.W. (Technische Hogeschool Delft (Netherlands)). Jan 1983. 28p. NTIS, PC A03/MF A01.

Photon absorption graphs for H_2 (liquid), He (liquid), Be, C, Al, Ar (gas), Fe, Cu, Ge, Kr (gas), Mo, Sn, Xe (gas), Dy, Aun, Pb, U, NaI, NE102A, Kapton, Mylar, Hostaphan, polyethylene, and BaF_2 are presented.

39277 Energy levels of channeled ions. Nekovic, N. (Boris Kidri Institute of Nuclear Sciences, Belgrade, Yugoslavia; Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Physical Review [Section] B: Condensed Matter;* **33**: No. 11, 7488-7493(1 Jun 1986). Contract W-7405-ENG-36.

Energy levels of ions moving along crystal channels are considered. The approach is via an effective Hamiltonian. The calculations are related to an experiment in which resonant coherent excitation of channeled ions was measured. The systems under consideration are 44.16-MeV N^{6+} and 38.28-MeV O^{7+} ions in the <100> channel of an 850-A-thick Au crystal. The distributions of the transition energies were generated by the Monte Carlo method: All possible values of the impact parameter were taken into account. The obtained results are in very good agreement with the results of the experiment.

39278 Equilibration lengths for K-shell charge-exchange processes for fast ions traversing foils - evidence from multiple-scattering distributions and Auger-yield measurements. Kanter, E.P.; Schneider, D.; Gemmell, D.S. (Argonne National Lab., IL). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 735-744(1982). (CONF-820855—). Contract W-31-109-ENG-38.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

Measurements on the angular distributions of fast ions traversing foils show a pronounced dependence of the multiple-scattering widths upon the charge state of the emerging ions. These results can be explained in terms of the large scattering angles achieved by those ions that bear K-vacancies. A quantitative model is described which demonstrates how the memory of K-vacancy producing collisions gives rise to large multiple-scattering widths in spite of apparent charge-state equilibration. These data, together with related measurements on projectile auger-electron yields, permit determination of the equilibration lengths for K-vacancy bearing fractions of ion beams traversing foils. 27 references, 5 figures.

6550 Medical Physics

REFER ALSO TO CITATION(S) 38717, 39268

39279 (LA-UR—86-2255) Techniques of absolute low energy x-ray calibration. Day, R.H. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 9p. (CONF-860880—6). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012426.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

Recent advances in pulsed plasma research, materials science, and astrophysics have required many new diagnostic instruments for use in the low energy x-ray regime. The characterization of these instruments has provided a challenge to instrument designers and provided the momentum to improve x-ray sources and dosimetry techniques. In this paper, the present state-of-the-art in low energy x-ray characterization techniques is reviewed. A summary is given of low energy x-ray generator technology and dosimetry techniques including a discussion of thin window proportional counters and ionization chambers. A review is included of the widely used x-ray data bases and a sample of ultrasoft x-ray measuring procedures, chopped x-ray source generators, phase sensitive detection of ultralow currents, and angular divergence measurements.

39280 (UCRL—93846) Facilities and techniques for x-ray diagnostic calibration in the 100-eV to 100-keV energy range. Gaines, J.L.; Wittmayer, F.J. (Lawrence Livermore National Lab., CA (USA)). Jun 1986. Contract W-7405-ENG-48. 11p. (CONF-860880—7). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012350.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

The Lawrence Livermore National Laboratory (LLNL) has been a pioneer in the field of x-ray diagnostic calibration for more than 20 years. We have built steady state x-ray sources capable of supplying fluorescent lines of high spectral purity in the 100-eV to 100-keV energy range, and these sources have been used in the calibration of x-ray detectors, mirrors, crystals, filters, and film. This paper discusses our calibration philosophy and techniques, and describes some of our x-ray sources. Examples of actual calibration data are presented as well.

6560 Solid-state Physics

REFER ALSO TO CITATION(S) 39071, 39109, 39118, 39119

39281 (LBL—21470) Calculating and predicting the properties of materials. Louie, S.G. (Lawrence Berkeley Lab., CA (USA)). Apr 1986. Contract AC03-76SF00098. 6p. (CONF-8604176—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86011557.

From Workshop on scientific applications and algorithm design for high speed computing; Champaign, IL, USA (7 Apr 1986).

Using microscopic theory, it is now possible to predict the structures and properties of real materials from first principles. This breakthrough was brought about by recent advances in the theory of the electronic structure of solids and by the availability of supercomputers. Many researchers in the field believe we are at the beginning of an era where we will be capable of designing materials with desirable properties using quantum theory and computers.

39282 (TRI-PP—86-16) New method to calculate the muon polarization function. Celio, M. (TRIUMF, Vancouver, British Columbia (Canada)). Apr 1986. 5p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86901534.

In this paper we report on a new technique developed to study the spin dynamics of a static positive muon interacting with neighboring nuclear spins. The method is based on Trotter formula and leads to exact results even when the dimension of the composite spin system is very large. First results are presented for the case of muons localized at the interstitial octahedral site in copper in an arbitrary magnetic field.

39283 Fracture mechanics model of fragmentation. (Physics Department, University of California, Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, California 94550). *Journal of Applied Physics;* 60: No. 3, 1224-1226(1 Aug 1986). Contract W-7405-ENG-48.

A model of the fragmentation process is developed, based on the theory of linear elastic fracture mechanics, which predicts the average fragment size as a function of strain rate and material properties. This approach permits a unification of previous results, yielding Griffith's solution in the low-strain-rate limit and Grady's solution at high strain rates.

39284 Capillary instabilities in thin films. I. Energetics. Srolovitz, D.J.; Safran, S.A. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Applied Physics;* 60: No. 1, 247-254(1 Jul 1986).

A stability theory is presented which describes the conditions under which thin films rupture. It is found that holes in the film will either grow or shrink, depending on whether their initial radius is larger or smaller than a critical value. If the holes grow large enough, they impinge to form islands; the size of which are determined by the surface energies. The formation of grooves where the grain boundary meets the free surface is a potential source of holes which can lead to film rupture. Equilibrium grain boundary groove depths are calculated for finite grain sizes. Comparison of groove depth and film thickness yields microstructural conditions for film rupture. In addition, pits which form at grain boundary vertices, where three grains meet, are another source of film instability.

39285 Capillary instabilities in thin films. II. Kinetics. Srolovitz, D.J.; Safran, S.A. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Applied Physics;* 60: No. 1, 255-260(1 Jul 1986).

We consider the kinetic evolution of perturbations to thin films. Since all small (nonsubstrate intersecting) perturbations to the film surface decay, we consider the evolution of large perturbations, in the form of a single hole which exposes the substrate. For large holes, the hole radius increases at a constant rate under the assumption of evaporation/condensation kinetics. When the dominant transport mode is surface diffusion, large holes grow with a rate proportional to t/sup -3/4/ [log^{3}(t/ rho^{4}/sub c/)]. Small holes with a radii less than rho/sub c/ shrink, where rho/sub c/ is the film thickness divided by the tangent of the equilibrium wetting angle. The growth of these holes eventually leads to hole impingement which ruptures the film, creating a set of disconnected islands. The relaxation time for these islands to go to their equilibrium shape and size (rho/sub eq/) scales as rho^{3}/sub eq/ or rho^{4}/sub eq/ for evaporation/condensation or surface diffusion kinetics, respectively.

39286 Comparative Monte Carlo and mean-field studies of random-field Ising systems. Grest, G.S.; Soukoulis, C.M.; Levin, K. (Corporate Research Laboratories, Exxon Research and Engineering Company, Annandale, New Jersey 08801). *Physical Review* [*Section*] *B: Condensed Matter;* 33: No. 11, 7659-7674(1 Jun 1986). Contract W-7405-ENG-82.

Site-dependent mean-field theory and Monte Carlo (MC) simulations are used to study and compare random-field Ising ferromagnets (RFIM) and Ising diluted antiferromagnets in a field (DAFF). For short-time-scale simulations the two approaches lead to similar results for the various history-dependent magnetizations, and specific heats and for the metastable ground-state spin configu-

rations. The results are also in reasonable qualitative accord with experiment. Mean-field theory which more readily provides information about free energies is used to compute the phase diagram for two- and three-dimensional random-field systems. Since thermal fluctuations are not important in the equilibrium critical behavior a mean-field approach is expected to contain much of the essential physics. At T = 0, MC simulations corroborate the mean-field results. We distinguish three characteristic field-dependent temperatures which in order of decreasing magnitude are the irreversibility temperature T/sub irr/, the ordering temperature (T/sub c/ or T/sub N/), and the temperature for stability of long-range order (LRO), T/sub s/. T/sub irr/ corresponds to the temperature at which the free-energy surface first develops multiple minima.

6561 Superconductivity

REFER ALSO TO CITATION(S) 38247, 38314, 38433

6570 Theoretical Physics

REFER ALSO TO CITATION(S) 38455, 39319

39287 (AD-A—166316/0/XAB) Strategy for time-dependent quantum-mechanical calculations using a Gaussian wave-packet representation of the wave function. Annual technical report. (California Univ., Santa Barbara (USA). Quantum Inst.). 15 Sep 1985. 22p. (TR—5). NTIS, PC A02/MF A01.

A methodology for performing time-dependent quantum-mechanical calculations is developed by representing the wave function as a sum of Gaussian wave packets (GWP) each characterized by a set of parameters such as width, position momentum, and phase. The problem of computing the time evolution of the wave function is thus reduced to that of finding the time evolution of the parameters in the Gaussians. The parameter motion is determined by minimizing the error made by replacing the exact wave function in the time-dependent Schroedinger equation with its Gaussian representation approximant. This leads to first-order differential equations for the time dependence of the parameters, and those describing the packet position and the momentum of each packet have some resemblance with the classical equations of motion. The paper studies numerically the strategy needed to achieve the best GWP representation of time-dependent processes. The issues discussed are the representation of the initial wave function, the numerical stability and the solution of the differential equations giving the evolution of the parameters, and the analysis of the final wave function. Extensive comparisons are made with an approximate method which assumes that the Gaussians are independent and their width is smaller than the length scale over which the potential changes.

39288 (FNAL/Pub—86/83-A) Kinematic tests of exotic flat cosmological models. Charlton, J.C.; Turner, M.S. (Fermi National Accelerator Lab., Batavia, IL (USA)). May 1986. Contract AC02-76CH03000. 39p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012302.

Theoretical prejudice and inflationary models of the very early Universe strongly favor the flat, Einstein-deSitter model of the Universe. At present the observational data conflict with this prejudice. This conflict can be resolved by considering flat models of the Universe which possess a smooth component by energy density. We study in detail the kinematics of such models, where the smooth component is relativistic particles, a cosmological term, a network of light strings, or fast-moving, light strings. We also discuss the observational tests which can be used to discriminate between these models. These tests include the magnitude-redshift, lookback time-redshift, angular size-redshift, and comoving volume-redshift diagrams and the growth of density fluctuations.

39289 (FNAL-TM—1402) Scalar potential for charge distributions with ellipsoidal symmetry. Gluckstern, R.L. (Fermi National Accelerator Lab., Batavia, IL (USA)). 20 May 1986. Contract AC02-76CH03000. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012599.

Calculation of the electrostatic scalar potential in ellipsoidal coordinates is outlined. The ellipsoidal coordinate system is described, and the Laplace equation is discussed for this system. Special charge distributions having ellipsoidal symmetry, and therefore most easily treated in ellipsoidal coordinates, are assumed and their scalar potentials calculated, including the ellipsoidal shell, two-dimensional and three-dimensional Gaussian charge distribution, and two-dimensional uniform distribution. 2 refs. (LEW)

39290 Closed, analytic, boson realizations for Sp(4). (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6396). *Journal of Mathematical Physics (New York);* **27**: No. 8, 1987-1993(Aug 1986).

The problem of determing a boson realization for an arbitrary irrep of the unitary simplectic algebra Sp(2d-italic) [or of the corresponding discrete unitary irreps of the unbounded algebra Sp(2d-italic,R-italic)] has been solved completely in recent papers by Deenen and Quesne [J. Deenen and C. Quesne, J. Math. Phys. 23, 878, 2004 (1982); 25, 1638 (1984); 26, 2705 (1985)] and by Moshinsky and co-workers [O. Castan-tildeos, E. Chaco-acute-accentn, M. Moshinsky, and C. Quesne, J. Math. Phys. 26, 2107 (1985); M. Moshinsky, "Boson realization of symplectic algebras," to be published]. This solution is not known in closed analytic form except for d-italic = 1 and for special classes of irreps for d-italic>1. A different method of obtaining a boson realization that solves the full problem for Sp(4) is described. The method utilizes the chain Sp(2d-italic)⊃SU(2) x SU(2) x xxx x SU(2) (d-italic times), which, for d-italic> or =4, does not provide a complete set of quantum numbers. Though a simple solution of the missing label problem can be given, this solution does not help in the construction of a mapping algorithm for general d-italic.

39291 Class of exactly soluble many-body Hamiltonians. Redondo, A. (Electronics Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *American Journal of Physics;* **54**: No. 7, 643-646(Jul 1986).

A class of exactly soluble N-particle Hamiltonians is presented. The matrix representation of these Hamiltonians, which consists of one- and two-body interactions, is block diagonal. The blocks consist of a finite-dimensional matrices which can be easily diagonalized. An example for a system with two particles is discussed.

39292 Mean power reflection from a one-dimensional nonlinear random medium. Spigler, R. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *Journal of Mathematical Physics (New York);* **27**: No. 7, 1760-1771(Jul 1986). Contract AC02-76ER03077.

A model of wave propagation in a slab 0< or =x< or =L of a nonlinear random medium is considered. The index of refraction is k[1+epsilon-tilde(x,w'u/sup epsilon/(x,L,w)'²)]¹/sup //², where epsilon-tilde(x,α) = εm(x)+ε²[(n(x)= +iδ(x))α+θ(x)+i γ(x)], with ε a small parameter, m,n,δ,θ,γ suitable stochastic processes, u/sup epsilon/(x,L,w) the wave field, and w> or =0 the intensity of nonlinearity. The mean reflected power is evaluated from a certain nonlinear partial differential equation satisfied by the reflection coefficient R/sup epsilon/(L,w).

39293 Nonequilibrium truncation scheme for the statistical mechanics of relativistic matter. Ploszajczak, M.; Rhoades-Brown, M.J. (Niels Bohr Institute, Blegdamsvej 17, DK-2100 Copenhagen O, Denmark). *Physical Review [Section] D: Particles and Fields;* **33**: No. 12, 3686-3696(15 Jun 1986).

In this paper we apply a new self-consistent truncation scheme to the infinite coupled hierarchy of transport equations that describe a relativistic plasma. In particular we describe in detail the truncated transport equations for a charged scalar plasma and a neutral scalar plasma in the pairing-approximation limit. We include a brief discussion of particle production within our language. The quantum-mechanical dynamical equations for a positive-energy electron plasma are also cast in a form suitable for approximation within our truncation scheme.

39294 Sound scattering from a thin rod in a viscous medium. Lin, W.H.; Raptis, A.C. (Components Technology Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439). *Journal of the Acoustical Society of America;* **79**: No. 6, 1693-1701(Jun 1986).

Sound waves incident on a thin elastic rod whose radius is smaller than the wavelength of the incident sound induce flexural and uniform compressional oscillations in the rod. These elastic oscillations, in turn, radiate sound waves into the fluid medium and affect the scattered waves. This paper deals with an analytic study on sound scattering by, and acoustoelastic vibrations of, a thin elastic unbound rod in a viscous fluid. The shear viscosity of the fluid is considered in the solutions to boundary value problems concerning the sound scattering and the elastic response of the rod. Results show that the scattered compressional waves consist of the rigid-rod scattering of compressional waves, monopolar waves due to the uniform pulsating of the rod, and dipolar waves due to the flexural vibration of the rod. The scattered viscous waves consist of the rigid-rod scattering of viscous waves and dipolar waves due to the flexural vibration of the rod. Acoustic resonances occur when the effective inertia force of the rod balances the stiffness force of the rod. The fluid viscosity and the scattering of sound give rise to damping effects for the rod vibrations and signficantly affect the acoustic resonances.

39295 Wave-packet evolution and quantization. Littlejohn, R.G. (Department of Physics, University of California, Berkeley, California 94720). *Physical Review Letters;* **56**: No. 19, 2000-2003(12 May 1986). Contract AC03-76SF00098.

A general relationship is established between wave-packet evolution and quantization in classically integrable systems. Because of wave-packet spreading, one cannot simply take the Fourier transform of the time evolution of a wave packet. Instead, one must propagate the wave packet using the actions as Hamiltonians. The energy eigenvalues which result are the Einstein-Brillouin-Keller values, and new forms for the eigenfunctions appear. These are free of caustic singularities, and represent averages of wave packets over the invariant torus.

39296 Monte Carlo simulation of self-avoiding surfaces in three dimensions. Glaus, U. (Institute of Theoretical Physics, Eidgenoessische Technische Hochschule, Honggerberg, 8093 Zurich, Switzerland). *Physical Review Letters;* **56**: No. 19, 1996-1999(12 May 1986). Contract FG05-84ER45071.

We present a new Monte Carlo algorithm for self-avoiding surfaces in a grand canonical ensemble. The topology of the surfaces is kept planar but the boundary is allowed to fluctuate during the simulation. The measured critical exponents $\nu = 0.504 +- 0.016$, theta = 1.48 +- 0.17 indicate that this model belongs to the universality class of branched polymers in three dimensions.

39297 Precise measurements of optical dispersion using a new interferometric technique. Velsko, S.P.; Eimerl, D. (Lawrence Livermore National Laboratory, Nonlinear Optical Materials Group, P.O. Box 5508, Livermore, California 94550). *Applied Optics;* **25**: No. 8, 1344-1349(15 Apr 1986). Contract W-7405-ENG-48.

Measurements of the dispersion of the refractive index using a nonlinear interferometer are described. A sample of the optical material to be measured is interposed between two optically nonlinear crystals, and a moderately intense laser is passed through the combination. By observing the interference between the second harmonics produced in the two nonlinear crystals, the difference between the refractive indices of the sample at the laser frequency and its second harmonic frequency can be determined very precisely. We have used the interferometer to measure the dispersion in several gases between 1064 and 532 nm. We have also used it to determine the dispersion of two transparent solids. The method can measure the index difference to better than 0.1%, which for gases such as helium represents an absolute accuracy of $\sim 10^{-9}$.

39298 Optics along the Rio Grande Research Corridor. Freese, K. (Los Alamos National Lab.). pp 606 of Southwest conference on optics. SPIE volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—).

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

New Mexico's scientific, technological, and educational resources are concentrated along a 300-mile stretch of the Rio Grande, from Los Alamos in the north to the Las Cruces in the south. This area contains two major multidisciplinary national laboratories (Los Alamos and Sandia), three military R & D centers, three state universities, and numerous other technology-based organizations, including a growing number of "high-tech" businesses and industries. The state of New Mexico has initiated a program to develop these resources for economic growth through the establishment of the Rio Grande Research Corridor. Much of the future development along the Corridor will involve optics and optical technologies. This session of the Southwest Conference on Optics reviewed the various projects in the Rio Grande Research Corridor, focusing on applications of optics.

39299 Four-photon resonant third harmonic generation. Smith, A.V. (Sandia National Laboratories, Albuquerque, NM 87185). pp 381-384 of Southwest conference on optics. SPIE Volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—). Contract AC04-76DP00789.

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The phenomenon of resonant enhancement of optical third harmonic generation near four-photon resonances is studied with the goal of understanding the nonlinear processes involved and evaluating them as a means of more efficiently generating coherent vacuum ultraviolet light.

39300 Electron- and photon-stimulated desorption. Knotek, M.L. (Sandia National Labs., Albuquerque, NM). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 772-786(1982). (CONF-820855—). Contract AC04-76DP00789.

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

This paper covers but a few of the salient points which are coming together to suggest that Electron Stimulated Desorption and Photon Stimulated Desorption can contribute greatly to our understanding of surfaces. Specifically, the highly specific local information content of stimulated desorption arises from the intrinsically highly localized processes leading to desorption. Recent examples of near edge and extended range PSD data, together with advances in the interpretation of near edge spectra promise a useful future for these measurements. 71 references, 6 figures.

6580 Mathematical Physics

REFER ALSO TO CITATION(S) 39070, 39445

39301 (ENEA-RT-TIB—85/20) ENA: a program for evaluating exponential integrals. Chiccoli, C.; Landini, P.; Lorenzutta, S.; Premuda, F. (ENEA, Bologna (Italy)). Oct 1985. 26p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86901545.

A formalized description is presented and numerical features are discussed for the ENA, a computer program for the computation of n member sequences of exponential integrals E/sub n/(x) (n greater than or equal to 1, x greater than 0). The main procedure and related sub-procedures are listed along with numerical results. 6 refs., 1 tab.

39302 (ORNL—6207) Quantitative assessment of the effect of partial pivoting in sparse ordinary differential equation solvers. Thompson, S. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012592.

The effect of partial pivoting in automatic ordinary differential equation solvers which utilize sparse matrix techniques is discussed. Two solvers are considered, the well-known LSODES solver and a derivate LSOD28. LSODES uses the Yale Sparse Matrix Package which does not perform partial pivoting. LSOD28 uses the Harwell MA28 Sparse Matrix Package which does perform partial pivoting. Results are presented for a benchmark problem which contains several features typically present in realistic problems. The results demonstrate that both solvers perform satisfactorily. At the same time, they demonstrate the relative effects of partial pivoting for the benchmark problem. In particular, they suggest that partial pivoting substantially improves neither the efficiency nor the reliability of LSODES for such problems. They support the argument that partial pivoting is not necessarily required in adaptive solvers to solve complex problems accurately and efficiently. 13 refs., 15 tabs.

39303 **Class of solvable second-order ordinary differential equations with variable coefficients.** Takayama, K. (Texas Accelerator Center, The Woodlands, Texas 77380). *Journal of Mathematical Physics (New York);* **27**: No. 7, 1747-1749(Jul 1986). Contract AC02-84ER40155.

The problem of solving the second-order ordinary differential equations with variable coefficients of the form $d^2x/dt^2+(q_1(t)+\lambda q_3(t))x = 0$ is treated. It is shown that if the initial equation $d^2x/dt^2+q_1(t)x = 0$ is in analytically solvable form and $q_3(t)$ is the inverse square function of a solution for the nonlinear auxiliary equation $1/2 \times d^2x/dt^2 - 1/4 (dx/dt)^2+q_1(t)x^2 = 1$, there are exact solutions. Using an inner relationship between solutions for the initial equation and the auxiliary equation, an infinite sequence of analytically solvable differential equations is constructed step by step. Typical examples of such a sequence are shown.

6590 Communication, Education, History, And Philosophy

39304 **(DOE/ER/40048—156-L6) [John Huizenga's nuclear physics research].** Vandenbosch, R. (Washington Univ., Seattle (USA)). 1986. Contract AC06-81ER40048. 8p. (CONF-8604165—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010440.

From International conference on heavy ion physics; Rochester, NY, USA (21 Apr 1986).

A background of John Huizenga's origins and a brief historical overview of his career are given. A short list of Huizenga's contributions to the field of nuclear physics is presented. These contributions include research concerning spontaneous fission, fission-neutron competition, nuclear level densities, structure of actinide elements by transfer reactions, fission fragment angular distributions, and heavy ion rections. 7 refs., 1 fig., 1 tab. (DWL)

39305 **1986 Richtmyer Lecture: Unification, grand unification, and the unity of physics.** Lederman, L. (Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510). *American Journal of Physics;* **54**: No. 7, 594-600(Jul 1986).

The relationships among the many specialized areas of physics are discussed. The historical aspects are briefly covered, and the relevance of the superconducting super collider is emphasized.

70 FUSION ENERGY

39306 **(DOE/ER/54025—T2) Cooperation and competition on the path to fusion energy.** (National Research Council, Washington, DC (USA)). 1984. Contract FG05-83ER54025. 139p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86012270.

The United States, the European Community, and Japan are actively considering whether worthwhile advantages lie in increased cooperation among their respective programs of research and development in magnetically confined fusion. To help answer that question for the United States, this report examines why cooperation is a policy option, what might be done, and how.

7001 Plasma Research

REFER ALSO TO CITATION(S) 39115, 39401, 39414, 39423

39307 **(CONF-860412—12) Confinement of high-density pellet-fueled discharges in TFTR.** Milora, S.L.; Schmidt, G.L.; Bell, M.G.; Bitter, M.; Bush, C.E.; Combs, S.K.; England, A.; Fredrickson, E.; Goldston, R.J.; Grek, B. (Princeton Univ., NJ (USA). Plasma Physics Lab.). 1986. Contract AC05-84OR21400. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012308.

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

TFTR pellet injection results reported by Schmidt have been extended to higher density and ntau in plasmas limited by a graphite inner-wall belt limiter. Increased pellet penetration and larger density increases were achieved by operation at reduced plasma current (1.6 MA), minor radius (70 cm), and major radius (235 cm). Under these conditions, beam heating results have been extended to 7 MW.

39308 **(DOE/ER/53194—01) Nonlinear magnetohydrodynamics. Progress report.** Montgomery, D.C. (Dartmouth Coll., Hanover, NH (USA). Dept. of Physics). 1985. Contract FG02-85ER53194. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012207.

Brief descriptions of work which has been completed on the Nonlinear Magnetohydrodynamics Project are given. These include discussions on plasma fluctuation processes as they affect the transport, confinement and heating of the plasma.

39309 **(DOE/ET/51013—181) Directional asymmetries in the Alcator C edge plasma.** Wan, A.S.; LaBombard, B.; Lipschultz, B.; Yang, T.F. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). May 1986. Contract AC02-78ET51013. 21p. (PFC/CP—86-7; CONF-860522—13). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012256.

From 7. international conference on plasma surface interactions in controlled fusion devices; Princeton, NJ, USA (5 May 1986).

A visual inspection of the full poloidal ring limiters used on Alcator C identifies two directionally asymmetric damage regions: at the inside-top location on the electron side (as defined by plasma current, I/sub p/) and at the inside-bottom location on the ion side. We report direct measurements of both ion and electron edge parameters using Janus, a two-sided, multi-diagnostic edge probe, which also indicates strong directional asymmetries. Higher ion and electron temperatures and densities at the probe location occur on the electron side when the toroidal field (B/sub t/) is antiparallel to I/sub p/. The degree of asymmetry cannot be explained by limiter configuration alone. The direction of B/sub t/ with respect to I/sub p/, and variation of the plasma in-out positions, change the magnitude of asymmetry. A number of mechanisms which may cause the directional asymmetries are examined, including parallel plasma flow and asymmetric perpendicular transport into the collecting flux tubes. Measurements made by DENSEPACK, a full poloidal array of Langmuir probes, show strong poloidal asymmetries in both plasma density and electron temperature throughout the scrape-off region of Alcator C. Such asymmetries may arise from asymmetric perpendicular transport and/or act to drive plasma flows along field lines. Thus, the dependence of the directional asymmetries on the directions of B/sub t/ and I/sub p/ may be explained.

39310 **(DOE/ET/51013—184) Ion and electron parameters in the alcator C tokamak scrape-off region.** Wan, A.S.H. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). May 1986. Contract AC02-78ET51013. 311p. (PFC/RR—86-13). NTIS, PC A14/MF A01; 1; GPO Dep. File Number DE86012587.

Janus is a bi-directional, multi-functional edge probe used to diagnose the ion and electron parameters in the Alcator C tokamak scrape-off region. Two mirror image sets of diagnostics are aligned to face the electron and ion sides along magnetic field lines. Each

set of diagnostics consists of a retarding-field energy analyzer (RFEA), a Langmuir probe, and a calorimeter. The RFEA can alternatively sample both the ion and electron parallel energy distribution functions during a tokamak discharge. From the Langmuir probe, one can infer electron temperature, density, and the plasma floating potential. Simple Langmuir probe theory is found to yield the best agreement between the measured Langmuir probe characteristics and the RFEA-inferred T/sub e/. The calorimeter independently detects the total parallel heat flux incident to an electrically floating plate. The measured sheath transmission coefficient, however, is typically lower than the theoretically predicted value by a factor of ~3. Together these diagnostics enable detailed, localized edge plasma characterization on Alcator C.

39311 (DOE/ET/53018—13) Study of plasma convection and wall interactions in magnetic confinement systems. Final report, December 1, 1984-February 28, 1986. York, T.M. (Pennsylvania State Univ., University Park (USA)). 1 Jun 1986. Contract AC02-76ET53018. 160p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86011919.

The subject contract research effort was initiated in September 1976 with two specific tasks: (1) to study the fundamental physics of confinement of an alternate concept (i.e., theta pinch based) devices; and (2) to study and to develop new diagnostic systems for use on major experiments at other locations in the country. There has been active collaboration with Los Alamos National Laboratory and Lawrence Livermore National Laboratory; there has been proposed collaboration with Princeton Plasma Physics Laboratory, Fusion Research Center at the University of Texas, and General Atomics.

39312 (KMSF-U—1757) SATIN: a fluid code to study the nonlinear evolution of two-plasmon decay and stimulated Raman scattering. Powers, L.V.; Berger, R.L. (KMS Fusion, Inc., Ann Arbor, MI (USA)). Sep 1985. Contract AC08-82DP40152. 14p. (CONF-8509302—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011862.

From CECAM workshop on interactions and instabilities in laser plasmas; Orsay, France (16 Sep 1985).

A fluid code SATIN has been developed to study the nonlinear evolution of two-plasmon decay and stimulated Raman scattering. Thresholds and growth rates for the linear phases of the instabilities have been obtained and compared to analytic results. The energy partitioning for saturation by pump depletion has been calculated. The method can be extended to include other nonlinear effects.

39313 (LRP—289/86) Papers contributed to the 13th European conference on controlled fusion and plasma physics by the TCA Group. Schliersee, Germany, April 1986. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Apr 1986. 30p. (CONF-860412—Exc.). NTIS (US Sales Only), PC A03/MF A01. File Number DE86901417.

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Included are 5 papers presented at the conference. They are: (1) A review of Alfven wave heating, (2) Observation of density fluctuations localized at the resonance layer during Alfven wave heating, (3) Central mass and current density measurements in tokamaks using the discrete Alfven wave spectrum, (4) Characteristics of broadband magnetic and density fluctuations in the TCA tokamak, and (5) Axisymmetric, resistive stability and control studies for the proposed TCV tokamak. (MOW)

39314 (LRP—290/86) Computing of RF heating and current-drive in tokomaks. Appert, K.; Hellsten, T.; Sauter, O.; Succi, S.; Vaclavik, J.; Villard, L. (Ecole Polytechnique Federale, Lausanne (Switzerland)). May 1986. 55p. (CONF-860515—2). NTIS (US Sales Only), PC A04/MF A01. File Number DE86901528.

From EPS conference on computational physics - computing in plasma physics; Partenkirchen, F.R. Germany (13 May 1986).

Two of the technically most developed numerical descriptions of radio frequency waves are discussed:Global-wave and quasilinear codes. The numerical approaches are presented within the physical context. The techniques considered are different finite element methods ranging from cubic Hermite finite elements to the non-conforming "finite hybrid elements". A high efficiency of the latter technique is demonstrated. The applications include Ion-Cyclotron Range of Frequency (ICRF) mode-conversion heating in JET, Alfven Wave Range of Frequency (AWRF) and ICRF Heating in TCV, and runaway production in Lower-Hybrid Range of Frequency (LHRF) ramp-up.

39315 (SAND—86-0039C) Metal impurity release in diverted tokamak discharges. Staudenmaier, G.; Wampler, W.R. (Sandia National Labs., Albuquerque, NM (USA); Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). 1986. Contract AC04-76DP00789. 20p. (CONF-860522—14). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012174.

From 7. international conference on plasma surface interactions in controlled fusion devices; Princeton, NJ, USA (5 May 1986).

Plasma materials interaction at the wall of the main plasma chamber of the divertor tokamak ASDEX was investigated by a combined probe, allowing simultaneous measurements of the erosion rate by neutral particles, and the flux and average energy of neutrals. The erosion was measured by collecting part of the released material on a carbon strip. Subsequent surface analysis was performed by electron induced x-ray analysis. Flux and energy of the impinging neutral particles were measured after each single discharge with an energy resolving carbon resistance probe. Such combined measurements yield the erosion yield being characteristic for the erosion process. Data for ohmic discharges in deuterium and helium are compared. It turns out that the carbon resistance probe is a simple but powerful means to study the metal impurity release from the tokamak walls by charge exchange neutrals.

39316 (UCRL—53727) Alpha particle density and energy distributions in tandem mirrors using Monte-Carlo techniques. Kerns, J.A. (Lawrence Livermore National Lab., CA (USA)). May 1986. Contract W-7405-ENG-48. 218p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE86012464.

We have simulated the alpha thermalization process using a Monte-Carlo technique, in which the alpha guiding center is followed between simulated collisions and Spitzer's collision model is used for the alpha-plasma interaction. Monte-Carlo techniques are used to determine the alpha radial birth position, the alpha particle position at a collision, and the angle scatter and dispersion at a collision. The plasma is modeled as a hot reacting core, surrounded by a cold halo plasma (T ~50 eV). Alpha orbits that intersect the halo lose 90% of their energy to the halo electrons because of the halo drag, which is ten times greater than the drag in the core. The uneven drag across the alpha orbit also produces an outward, radial, guiding center drift. This drag drift is dependent on the plasma density and temperature radial profiles. We have modeled these profiles and have specifically studied a single-scale-length model, in which the density scale length (r/sub pD/) equals the temperature scale length (r/sub pT/), and a two-scale-length model, in which r/sub pD//r/sub pT/ = 1.1.

39317 Radio-frequency-induced current and transport in toroidal plasmas. Antonsen, T.M. Jr.; Yoshioka, K. (Laboratory for Plasma and Fusion Energy Studies, University of Maryland, College Park, Maryland 20742). *Physics of Fluids;* **29**: No. 7, 2235-2248(Jul 1986). Contract AC05-84ER53170.

The theory of current generation and transport in toroidal geometry as a result of the absorption of high-frequency waves is developed. The radial particle and heat fluxes as well as the parallel current are given in terms of velocity moments of the RF-induced velocity space particle flux. The radial flux can be separated into classical and neoclassical parts. It is suggested that the absorption of RF can be used to control impurity transport.

39318 Nonlinear diocotron mode. Prasad, S.A.; Malmberg, J.H. (University of California at Los Angeles, Los Angeles, California 90024). *Physics of Fluids;* **29**: No. 7, 2196-2201(Jul 1986). Contract AM03-76SF00010.

A perturbation procedure for the construction of a nonlinear diocotron mode of an infinite length cylindrical pure electron plasma column is presented. The plasma is modeled as a cold fluid executing E x B drift in a strong axial magnetic field. The mode has no axial variation and depends on θ (azimuthal angle) and t (time) through the combination θ-Ωt. Thus the potential and the density are stationary in the frame rotating with angular frequency Ω. In this frame, the potential satisfies the relation del^{2}phi = F(phi) where F is a function of phi only. This equation is solved perturbatively to determine a nonlinear mode supported by a cylindrically symmetric equilibrium density profile. The properties of the mode depend only on the offset of the plasma column from the axis of the bounding conducting cylinder and the frequency of the mode is larger than the value predicted by linear theory by an amount roughly proportional to the square of the offset.

39319 Fiber-optic heterodyne phase-shift measurement of plasma current. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Applied Optics;* **25**: No. 11, 1770-1774(1 Jun 1986).

By combining twisted optical sensing fiber and heterodyne phase detection of circular birefringence we have (a) overcome the distortion problem caused by residual linear birefringence in the Faraday rotation method of measuring enclosed current and (b) used only a single output detector without requiring intensity normalization. Resolution of 400 ampere-turns has been obtained in the hostile electromagnetic environment of a working thermonuclear fusion research device. The fiber was simply wound around the existing machine. The measured values are in excellent agreement with those of the electrical Rogowski coil installed when the machine was built.

39320 Equipotential surfaces in the Proto-Cleo Torsatron. Trost, P.K.; Shohet, J.L. (Torsatron/Stellarator Lab., Univ. of Wisconsin-Madison, Madison, WI 53706). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 3, 215-219(Jun 1986).

Plasma potential measurements are made in electron cyclotron resonance plasmas in the Proto-Cleo Torsatron with an emissive probe. Plots of equipotential surfaces are presented and compared with the numerical calculated vacuum magnetic surfaces.

39321 Transport effects of interacting hot and cold electrons in laser-heated plasmas. Campbell, P.M. (KMS Fusion, Inc., Ann Arbor, MI 48106). *Fusion Technology;* **9**: No. 3, 391-400(May 1986).

The observation that heat flux anomalies may be related to laser intensity with a threshold of $\approx 1 \times 10^{14}$ W/cm^2 suggests that hot electrons, which become significant for values of $I\lambda^2$ above this threshold, may be a factor in the observed reduction of thermal heat flow. A formulation of heat transport in plasmas with a two-component electron distribution is developed, and solutions are found that are valid in large gradients. Specific transport effects arising from the hot and cold electron interaction are demonstrated in sample calculations. It is found that when the interaction between the two electron groups is considered in conjunction with the properties of hot electron formation, many of the heat flow anomalies observed in experiments can be explained.

39322 Infrared thermography of first wall components on the Tandem Mirror Experiment Upgrade. Watkins, J.G.; Dykhuizen, R.C.; Hsu, W.L.; Hill, D.N.; Allen, S.L. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1207-1209(May 1986). Contract AC04-76DP00789;W-7405-ENG-48.

Infrared thermography in the 8—12 μ wavelength range was used to measure surface heating on the low energy neutral source (LENS) plates in the Tandem Mirror Experiment Upgrade (TMX-U). A surface temperature rise of 3.5 °C was observed at the plasma edge during discharges lasting 70 ms with edge densities of approximately 10^{13} cm^{-3}. However, surface heating appeared to be nonuniform azimuthally in that the bottom plates showed a greater temperature rise. A few seconds after the termination of the discharge an axial view of the TMX-U revealed an additional form of surface heating. This is consistent with observations from the x-ray diagnostic which showed that a significant concentration of energetic electrons remained after the bulk thermal plasma had disappeared; these electrons disappeared only after the magnets were turned off. Details of the experiment and our experiences with this diagnostic tool will be presented.

39323 Long-term changes in the sensitivity of quadrupole mass spectrometers. Blanchard, W.R.; McCarthy, P.J.; Dylla, H.F.; LaMarche, P.H.; Simpkins, J.E. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1715-1719(May 1986). Contract AC02-76CH03073.

We routinely use quadrupole mass spectrometers (QMS) to monitor vacuum conditions, gas purity, and plasma—wall interactions in the Tokamak Fusion Test Reactor (TFTR) at Princeton. Two QMS systems have been operating on TFTR continuously for a 2 year period. Both QMS systems are absolutely calibrated at weekly intervals using a six-part standard gas mixture. The calibration procedure is based on the use of transfer standards (ion gauge and capacitance manometer) that are calibrated against a primary standard (spinning rotor gauge) on an external vacuum system. We have identified variations in the efficiency of the QMS ionizer and drifts in the sensitivity of the electron multiplier ion detector to be the major reasons for the observed changes in overall QMS sensitivity. Weekly variations in sensitivity greater than 100% have been observed following system bakeout at 150°C and with the use of rhenium filaments which were initially in the QMS ionizer. Operation of the QMS system with tungsten filaments and at constant temperature has yielded more stable operation with weekly sensitivity changes generally being less than 10%.

39324 Operation of cold-cathode magnetron gauges in high magnetic fields. Thomas, S.R. Jr.; Goerz, D.A.; Pickles, W.L. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1736-1739(May 1986). Contract W-7405-ENG-48.

The Mirror Fusion Test Facility (MFTF-B), under construction at LLNL, requires measurement of the neutral gas density in high magnetic fields near the plasma at several axial regions. This background gas pressure (BGP) diagnostic will help us understand the role of background neutrals in particle and power balance, particularly in the maintenance of the cold halo plasma that shields the hot core plasma from the returning neutrals. The BGP consists of several cold-cathode, magnetron-type gauges stripped of their permanent magnets, and utilizes the MFTF-B ambient B-field in strengths of 5—25 kG. Similar gauges have operated in TMX-U in B-fields up to 3 kG. To determine how well the gauges will perform, we assembled a test stand which operated magnetron gauges in an external, uniform magnetic field of up to 30 kG, over a pressure range of 10^{-9}—10^{-5} Torr, at several cathode voltages. This paper describes the test stand and presents the results of the tests.

39325 Laser spectroscopy of sputtered atoms. Gruen, D.M.; Pellin, M.J.; Young, C.E.; Calaway, W.F. (Materials Science & Technology and Chemistry Divisions, Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1779-1785(May 1986). Contract W-31-109-ENG-38.

The use of laser radiation to study the sputtering process is of relatively recent origin. Much has been learned from this work about the basic physics of the sputtering process itself through measurements of velocity and excited state distributions of sputtered atoms and the effects of adsorbates on substrate sputtering yields. Furthermore, the identification, characterization, and sensitive detection of sputtered atoms by laser spectroscopy has led to the development of in situ diagnostics for impurity fluxes in the plasma edge regions of tokamaks and of ultrasensitive methods (ppb Fe in Si) for surface analysis with ultralow (picocoulomb) ion fluences. The techniques involved in this work, laser fluorescence and multiphoton resonance ionization spectroscopy, will be described and illustrations given of results achieved up to now.

39326 Electric probes in plasmas. Lipschultz, B.; Hutchinson, I.; LaBombard, B.; Wan, A. (Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1810-1816(May 1986). Contract AC02-78ET51013.

This paper provides a background for the use of Langmuir and gridded energy analyzer probes in diagnosing plasmas with varied characteristics. Theory is illustrated which governs the analysis of data from, and the design of these probes. Several probe analysis techniques and some of their typical problems are presented.

39327 Characterization of the Tokamak Fusion Test Reactor plasma edge by Langmuir—calorimeter probes. Kilpatrick, S.J.; Manos, D.M.; Budny, R.V.; Stangeby, P.C.; Ritter, R.S.; Young, K.M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 3, 1817-1821(May 1986). Contract AC02-76CH03073.

Two combination Langmuir—calorimeter probes were operated on the Tokamak Fusion Test Reactor (TFTR) midplane to measure plasma properties of the scrape-off layer. Two different calorimeter elements were used: 0.5 x 3 x 8 mm Ta plates or 6.4 mm diameter graphite rods fitted with thermocouples. Separate graphite rods served as Langmuir elements. This paper presents Langmuir probe measurements of the radial profiles of edge density and electron temperature, and calorimeter measurements of heat flux. The variation of these quantities in certain operational regimes are presented, including dependence on Ohmic and neutral beam heating, compression and free expansion, plasma major and minor radii, plasma current, and line integral density with and without Cr gettering.

39328 Lyapunov stability conditions for relativistic multifluid plasma. Holm, D.D.; Kupershmidt, B.A. (Los Alamos National Lab. (LANL), NM, USA. Center for Nonlinear Studies; Los Alamos National Lab. (LANL), NM, USA. Theoretical Div.; Tennessee Univ., Tullahoma, USA. Space Inst.). *Physica D: Nonlinear Phenomena (Amsterdam);* **18**: No. 1-3, 405-409(Jan 1986). (CONF-850165—). Contract W-7405-ENG-36.

From Conference on solitons and coherent structures; Santa Barbara, CA, USA (11 Jan 1985).

The Hamiltonian structure is given for ideal relativistic multifluid plasma dynamics in the laboratory frame with the Hamiltonian functional equaling the relativistic energy minus the mass energy. The noncanonical Poisson bracket for this system turns out to be the same as for the nonrelativistic multifluid plasma, but with dynamical variables replaced by their relativistic counterparts. New constants of the motion are then derived from the Hamiltonian structure and used as Lyapunov functionals for proving sufficient conditions for nonlinear stability of relativistic multifluid plasma equilibria. The nonrelativistic multifluid plasma reemerge in that limit.

39329 (ORNL/tr—86/21) Application of the resonant fluorescence method to the diagnostics of helium-like carbon in the T-10 tokamak. Moskalenko, I.V.; Shcheglov, D.A. (Oak Ridge National Lab., TN (USA); Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1986. Contract AC05-84OR21400. Translation of IAE-4227/7, Moscow, 1985. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012186.

This paper offers an analysis of the applicability of laser resonant fluorescence (LRF) methods to a study of the behavior of highly charged ions of light elements. A description of the radiation source utilizing a doubling of the frequency of the dye laser with the aid of a potassium pentaborate crystal is given. The source is intended for optical pumping of 2 $^2S_1 \rightarrow 2\ ^2P$/sub 0,1,2/ transitions in the helium-like carbon ion. A system of diagnostics by the LRF method in the T-10 tokamak and the regimes in which the measurements were performed are described. A number of experimental results are presented.

39330 Application of the gyrokinetic equation to high frequency R.F. . Chiu, S.C. (GA Technologies, Inc., San Diego, CA, USA). *Plasma Physics and Controlled Fusion;* **27**: No. 12B, 1525-1537(Dec 1985).

A general electromagnetic conductivity tensor for inhomogeneous magnetic field is derived from the gyrokinetic equation for arbitrary frequency and distribution using Littlejohn's Lagrangian approach. A generalized gyrokinetic quasilinear operator is also obtained. For the ion-cyclotron range of frequencies, a full wave equation for the fast and Bernstein wave near the second harmonic is derived.

39331 Calculation of the self-consistent electric field in toroidal nonaxisymmetric devices. Hastings, D.E.; Kamimura, T. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Computational Physics;* **61**: No. 2, 286-296(Nov 1985). Contract AC05-84OR21400.

In a toroidal nonaxisymmetric plasma, the radial electric field is determined by the constraint that the radial ion and electron fluxes be equal. This ambipolarity relationship is in general a nonlinear algebraic equation for the electric field that can have multiple solutions. An algorithm is proposed here to solve this equation and obtain a spatially continuous, temporally stable solution. For definiteness, this is applied to a bumpy torus, and it is shown that there exists a boundary in the density, electron temperature, and ion temperature space across which the potential changes abruptly from a spatial hill to a spatial well.

39332 Spatially and temporally resolved diagnostics for microsecond, intense electron beams. Gilgenbach, R.M.; Brake, M.; Horton, L.D.; Bidwell, S.; Lucey, R.F.; Smutek, L.; Tucker, J.E. (Nuclear Engineering Dept., Univ. of Michigan, Ann Arbor, MI). pp 2R-1 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—).

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Experiments are underway to investigate new diagnostics for electron beams in vacuum and in a plasma background. Measured parameters include temporally resolved beam current profile and beam emittance. These characterizations are being performed during electron beam diode closure experiments (1) and beam-plasma interaction experiments with either of two long-pulse accelerators: MELBA (Michigan Electron Long Beam Accelerator): Voltage = -1 MV, Current = 10 kA, at Pulselength = 0.1 to 1μs (1.4μs) for voltage flat to within +.7% (+.10%). The second accelerator is a long-pulse Febetron with parameters: Voltage = -0.5 MV, Current = 1 kA, and Pulselength = 0.3 s. Two different configurations have been developed which use Cerenkov radiation to detect electron beam current profiles as a function of time. The first uses Cerenkov emission by electrons which impinge axially on a single fiberoptic lightguide enclosed in a lucite tube. Plasma light is blocked by graphite spray or thin foil covering the end of the optical fiber. This diagnostic has the following advantages: 1) The threshold energy for Cerenkov emission effectively discriminates between high energy beam electrons and low energy (3-5 eV) plasma electrons, 2) The small, nonconducting probe introduces a minimal perturbation into the beam-plasma system, 3) Excellent signal to noise ratio is obtained because the fiberoptic signal is directly transmitted to a photomultiplier tube in the Faraday cage, 4) Quantitative data is obtained directly.

39333 Progress in large-area, multiple-aperture acceleration of volume-produced H^- ions. Lietzke, A.F.; Hauck, C.A. (Lawrence Berkeley Lab., Berkeley, CA). pp 4P-6 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC03-76SF00098.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

A 15-cm^2 multiple-aperture (6-slot), single-stage accelerator is being used at Lawrence Berkeley Laboratory to investigate area scaling and H^- production physics associated with scaling-up from

the small-hole, low-density tests of Leung, toward the high-density, large-area requirements anticipated by users (10 A, 50 mA/cm²). Magnets within the grid structure also permit the study of electron supression and removal techniques. Thus far, the maximum average H^- intensity (3 mA/cm²) has been considerably lower than expected (30 mA/cm²). This has been traced partly to non-uniformity (<2X), and partly to the electron supression B-field (<3X). The remaining discrepancy has not yet been located. Likewise the accelerated electron content (50 - 600 mA, depending on conditions) is puzzlingly high. Thus far, the H^- production and the electron content have been found to depend upon the location and direction of the bucket filter's B-field, the potential of the beam-forming grid (Grid 1), the source pressure, the plasma density and the electron temperature. The maximum H^- intensity and minimum electron intensity is usually associated with the lowest electron temperature. A small positive bias on the beam forming grid has been helpful only at low plasma densities; and at each pressure, the H^- intensity saturates as the plasma density increases. Likewise, at each plasma density an optimum pressure is observed (higher pressure correlates to denser plasma).

39334 Effect of wall material on H^- production in a multicusp source. Leung, K.N.; Ehlers, K.W.; Pyle, R.V. (Lawrence Berkeley Lab., Berkeley, CA). pp 4P-5 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC03-76SF00098.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

H^- or D^- ions are required to generate efficient neutral beams with energies in excess of 150 keV. A magnetically-filtered multicusp source is capable of producing high-quality volume-generated H^- beams with sufficient current density ($\approx$ 40 mA/cm²) to be useful for both neutral beam heating of fusion plasmas and accelerator applications. Attempts have been made to further improve the arc efficiency of this source in order to provide the capability of long pulse or dc operation. The effect of wall material and wall temperature on the H^- ion density has been studied by Graham in a high pressure, diffusion-type plasma. No significant difference in negative ion densities has been observed for Pyrex, stainless steel, copper or molybdenum. In this paper, the authors investigate the extracted H^- beam with different metallic liners installed in a magnetically-filtered multicusp source (15 cm diam by 24 cm long). These metal liners were cleaned in an ultrasonic alcohol bath before installation. To insure good thermal and electrical contact with the source chamber, two stainless-steel rings were used to force the liner to lay flush against the vessel wall. A steady-state hydrogen plasma was produced by primary electrons emitted from two 0.05-cm-diam tungsten filaments.

39335 The transition to turbulence in a beam plasma. McCowan, R.; Waish, J. (Dartmouth Coll.). pp 5P-1 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—).

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Chaotic behavior now appears to be a universal phenomenon in nonlinear systems. The present work is an attempt to observe chaotic behavior of longitudinal plasma modes in a beam plasma. The experiment consists of a strongly magnetized electron beam formed plasma column with an electron density of 10^9 to 10^{10} electrons/cm³. The plasma is probed with a second beam with voltages from 0 to 1000 volts, and currents from 0 to 30 mA. The purpose of this second beam is to drive natural modes of the bounded system unstable, the nature of these unstable waves is studied. Correlations between amplitudes of different frequency modes have been observed in this system, as have amplitude time sequences indicative of period doublings and chaotic behavior explained by maps. Newly acquired digital data acquisition and control equipment have been added to the experimental system to measure the power spectra, time evolution, auto and cross correlations of plasma density, temperature and energy in various modes of the plasma.

39336 Effects of minority ions on the propagation of the Fast Alfven wave. Wong, K.L.; Kristiansen, M.; Hagler, M. (Dept. of Electrical Engineering/Computer Science, Texas Tech. Univ., Lubbock, TX). pp 5P-6 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—).

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Minority ions play an important role in ICRF wave heating and fast wave current drive. The former provides supplemental heating to the plasma ions, and the latter enables a Tokamak reactor to operate in steady state. The injection of minority ions greatly perturbs the propagation and absorption properties of the fast waves provided that the excitation frequency and confining magnetic field strength make the hybrid layers exist inside the plasma. A cold-plasma alab model with gradient confining magnetic field, parabolic plasma density, vacuum layer, launching antenna and conducting walls was used in studying wave propagation with and without minority ions. The wave propagation was studied individually for each discrete toroidal eigenmode (N=Rk/sub z/). There exists an asymmetric density cutoff region which is mainly due to the density variation in a single-ion plasma. The larger the torodial mode number, the larger the density cutoff region. Therefore, there exists a maximum mode number N/sub m/, which can be excited for each operating frequency. With injection of minority ions, the cutoff region for each mode number is almost unchanged. But, if one carefully chooses the excitation frequency; the hybrid layers can exist inside the plamsa for all or part of the allowed eigenmodes. Those eigenmodes with hybrid layers inside the plasma will undergo drastic change in the propagation and absorption of the waves.

39337 An experimental study of plasma waves generated by co-linear optical mixing. Umstadter, D.; Darrow, C.; Clayton, C.; Joshi, C. (Univ. of California, Los Angeles, CA). pp 5P-7 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AS03-83ER40120.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Longitudinal plasma waves produced by the resonant heating of two transverse electromagnetic waves are of interest for several reasons. First, it has been predicted theoretically and demonstrated in simulations that the exceedingly large electric field of such a wave may be used to accelerate particles to high energies. Secondly, because the plasma wave necessarily obeys the plasma dispersion relation, it may serve as a versatile and accurate plasma density probe. Furthermore, several schemes have been proposed to locally heat plasmas using the damping of these waves. The latter application is particularly relevant to the study of ionospheric plasma physics and cross-field transport. We present here results appropriate to all of these research avenues. These investigations also raise some interesting new questions concerning plasma wave-wave interactions. In co-linear optical mixing, two electromagnetic waves with slightly differing frequencies are injected parallel into a plasma. If the plasma density is such that the plasma frequency approximately matches the difference frequency of the EM waves, then a longitudinal electrostatic wave will be resonantly excited. The two EM waves in this experiment are the 9.6 μm line (4J) and the 10.6 μ line (12J) of a CO_2 laser. An arc discharge preionizes hydrogen gas to provide the initial plasma. The resonant plasma density corresponding to these wavelengths, 1.1 x 10^{17} cm^{-3}, is diagnosed by means of ruby Thomson scattering and tuned by varying the arc parameters. The authors observe at this resonant density ruby light, both red- and blue-shifted by ωp, at an angle of 7°.

39338 Basic plasma experiments relevant to fusion, space and plasma processing problems. Hershkowitz, N. (Univ. of Wisconsin-Madison, Madison, WI). pp 1A-1 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC02-78ET51015.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

This paper considers a variety of experimental situations which exhibit the interaction between basic plasma studies and applied plasma situations (fusion and space plasmas). Plasmas near fusion device boundaries often have many of the characteristics of both systems, possessing properties of collisionless plasmas and sheaths but incorporating important effects from particle recycling at boundaries. Probes, long regarded as too perturbing for fusion devices are now beginning to play a useful role. Studies of probes in RF situations are likely to result in improved fusion diagnostics. The authors first worked on the development of emissive probes in order to improve the understanding of self-consistent electric fields in small laboratory multidipole plasmas, and then to study double layers. Now emissive probes are beginning to find their way into measurements of edge and bulk plasmas in fusion experiments. Electrostatic shocks, sheaths, double layers and multiple double layers are beginning to turn up in many problems. Some problems have their origin as basic plasma experiments while others are born as fusion issues and then studied in the context of basic plasma questions before reappearing as fusion experiments. For example, axial ponderomotive force wandered from cusp plugging experiments to basic plasma experiments and then returned to provide MHD stability for fusion experiments in the form of radial ponderoomotive force.

39339 Quasilinear theory in general magnetic geometry. Chiu, S.C. (GA Technologies Inc., San Diego, CA). pp 4R-1 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC03-84ER53158.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Quasilinear theory is widely considered to be a convenient starting point of RF modeling when non-Maxwellian nature of the distribution function is important. In general magnetic geometry, this equation can be derived from gyrokinetic equations. Alternatively, we can use the equations of guiding center Hamiltonian to calculate the correlations and apply the Chandrasekhar-Fokker-Planck theory to derive the quasilinear equations. In this paper, the authors derive the equation from both approaches. They find that the two approaches are equivalent. However, the latter approach can be more convenient in avoiding some singularities. The resolution of these singularities shall be discussed within the framework of the latter approach.

39340 Coupling of fast waves in the LHRF to non-uniform plasma. Pinsker, R.I.; Duvall, R.; Colestock, P.; Hwang, D.Q.; Fortgang, C.; Douglas, M. (Princeton Univ.). pp 4R-3 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC02-76CH03073.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Current drive in the LHRF (ω/sub CI/ $<<$ $\omega \approx$ ω/sub PI/ $<<$ ω/sub CE/) by waveguide-array launched slow waves has been successfully demonstrated in several large tokamak experiments. Current drive using the fast wave branch of the cold plasma dispersion relation has recently been proposed, and an experimental program to evaluate the feasibility of fast wave current drive (FWCD) is underway at PPPL. The primary advantage of FWCD is that the fast wave has the potential of penetration beyond the lower hybrid resonance layer. An important topic of investigation in the FWCD experiments is the wave coupling physics at the waveguide-plasma interface. The minimum density required for fast wave propagation is much higher than the cut-off density for the slow wave. A finite-sized antenna could launch a significant fraction of power into the inaccessible part of the $n_{\parallel}$ spectrum; previous analytic work has neglected this spectral region, and has been limited to particular model density profiles. For $n_{\parallel}$ values below the accessibility criterion, the density window between fast wave cut-off and the mode coupling layer where the fast and flow branches coalesce is quite narrow. In this work, the authors consider a slab model of the plasma in the coupling region, with a straight magnetic field and density varying only in the crossfield direction.

39341 Ecrh heating experiments at $\omega = 2\omega$/sub CE/ in the end plugs of the phaedrus tandem mirror. Sing, D.; Hershkowitz, N.; Scharer, J. (Univ. of Wisconsin, Madison, WI). pp 2P-4 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC02-78ET51015.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Electron heating experiments at $\omega = 2\omega$/sub CE/ have been performed in the end plugs of the Phaedrus Tandem Mirror. Typical target plasma parameters in the plug are $n = 3 \times 10^{12}$/ cm^{-3}, T/sub E/ = 15 to 20 eV, and E/sub I/ = 600 to 800 eV. Pulses of 15.5 GHz microwaves at power levels of up to 30 kW and up to 1 ms in duration were injected into a single end plug when the machine is run as a quadrupole stabilized tandem mirror. Increases in plasma energy of up to 300 eV per electron-ion pair have been measured using diamagnetic loops. Thomson scattering has measured an increase in the bulk electron temperature of 30% during the microwave pulse. Measurements with a 3 channel target SXR detector have detected the presence of a hot electron tail with energies in excess of 10 keV. Microwave emission from hot electrons is detected by an 8 Ghz radiometer up to 50 ms after the cessation of the microwave power pulse and the plasma discharge.

39342 Analysis of halo-recycler operation on TMX-U. McGrath, R.T. (Fusion Tech. Div.-6248, Sandia National Lab., Albuquerque, NM). pp 2P-7 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC04-76DP00789.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

An analysis of particle and power flow in the halorecycler recently installed on the central cell region of TMX-U has been carried out. The primary function of the recycler is to achieve a high halo plasma density which shields the central cell core plasma from neutrals returning from the walls. This reduces energy loss by charge exchange in the central plasma and allows the core to be maintained at a higher temperature. Operating without halo recyclers TMX-U has achieved halo plasma densities near 2×10^{12} /cm^3 with electron temperatures near 20 eV. This is accomplished by directly heating the central cell and halo plasma with neutral beams. With recyclers it is hoped that a higher density halo plasma can be established. In this work power losses from the halo region are calculated for the three sets of halo plasma conditions. The plasma descriptions near the neutralizing end plates of the recycler have been calcualted using KTIC, a one dimensional kinetic plasma-neutral interaction model. This model provides the plasma description used in DEGAS, the three dimensional, Monte Carlo code for neutral hydrogen interaction with a background plasma and with material surfaces. In each of the cases investigated the recycler is found to be effective in reionizing the hydrogen flux incident on the neutralizer and neutral pressures at the recycler throat entrance, 50 cm from the neutralizer, are calculated to be near the background pressure of 10^{-6} torr.

39343 A direct indication of plasma potential diagnostic with fast time response and high accuracy based on a differential emissive probe. Yao, W.E.; Hershkowitz; Intrator, T. (Nuclear Engineering Dept., Univ. of Wisconsin, Madison, WI). pp 3R-7 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC02-78ET51015.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The floating potential of the emissive probe has been used to directly measure the plasma potential. The authors have recently presented another method for directly indicating the plasma potential with a differential emissive probe. In this paper they describe the effects of probe size, plasma density and plasma potential fluctuation on plasma potential measurements and give methods for reducing errors. A control system with fast time response (α 20 μs) and high accuracy (the order of the probe temperature T/sub w// e) for maintaining a differential emissive probe at plasma potential

has been developed. It can be operated in pulsed discharge plasma to measure plasma potential dynamic characteristics. A solid state optical coupler is employed to improve circuit performance. This system was tested experimentally by measuring the plasma potential in an argon plasma device an on the Phaedrus tandem mirror.

39344 **A survey of TFTR diagnostics.** Staloff, C. (Princeton Univ., Plasma Physics Lab., Princeton, NJ). pp 1199-1209 of Fusion technology 1984. Volume 2. Elmsford, NY; Pergamon Press (1985). (CONF-840915—). Contract AC02-76CH03073.

From 13. symposium on fusion technology; Varese, Italy (24 Sep 1984).

TFTR is currently using 56 individual diagnostic systems to measure significant plasma and machine performance parameters and to supply collected information to the TFTR data processing and control systems. Most of this diagnostic equipment was designed, developed, and constructed at PPPL specifically for TFTR. This paper gives a general overview of TFTR diagnostics and describes a representative subset of the unique PPPL equipment.

39345 **Application of time-domain spectroscopy to antenna impedance measurements in an isotropic plasma.** Larocque, J.P.; Renaud, P.R. (Dept. of Electrical Engineering, École Polytechnique of Montreal, P.O.B. 6079, Station "A", Montreal). pp 4P-3 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC03-76SF00098.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Time-domain reflectometry (TDR) [1], digital signal processing and fast Fourier transform (FFT) are combined in order to evaluate, over a wide range of frequencies, the impedance of a linear antenna immersed in an isotropic plasma. A step-like waveform (from a TDR cable tester) is fed to the antenna. The return signal, which contains the information on the antenna's complex reflection coefficient and is displayed on a wide-band oscilloscope, is sampled and digitized. A reference pulse, coming from a precision short-circuit replacing the antenna, is processed similarly,. Subsequently the FFT is applied to both signals and the antenna impedance (or admittance) is computed as a function of frequency. The experiments are conducted with a short, thin-wire monopole immersed in a diffusion-type argon plasma (neutral gas pressure: 5 x 10^{-3} torr). A DC-bias can be applied to the antenna and thus the thickness of the ion sheath surrounding it can be changed.

39346 **Performance analysis of the vertical viewing ECE diagnostic for non-thermal electron distribution measurement.** Kato, K.; Hutchinson, I.H. (Plasma Fusion Center, MIT). pp 2C-1 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC02-78ET51013.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The vertical viewing electron cyclotron emission (VECE) system on Alcator C tokamak is designed to analyze the non-thermal electron velocity distribution during lower hybrid current drive. The system employs vertical chord viewing through the center of the plasma to eliminate magnetic field variation along the line of sight, and a viewing dump made of Pyrex or Macor to decrease the effects of wall reflection and polarization scrambling. A rapid-scanning Michelson interferometer is used to obtain the frequency spectra. In principle, this design makes the frequency spectrum predominantly a function of the electron energy due to the relativistic mass shift. Effectiveness of the dump and the collection optics is evaluated by comparing the second harmonic thermal emission with and without the viewing dump. Results are summarized below. These results clearly show the polarized nature of the thermal emission in the second harmonic, and demonstrate the possibility of decreasing both the wall reflection and polariation scrambling by use of a compact (7cm x 7cm) viewing dump. The effectiveness of the viewing dump in reducing the background level is found to be approximately 90% for both modes in the second harmonic frequency range. Preliminary inspection of the non-thermal spectra in the second harmonic show the effect of background absorption to vanish with the installation of the dump.

39347 **A review of diagnostics for measuring local potentials and magnetic fields in high temperature plasma.** Osher, J.E. (Lawrence Livermore National Lab., Livermore, CA). pp 2C-3 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract W-7405-ENG-48.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The systematic control of local potentials and magnetic fields is fundamental to magnetic fusion confinement experiments. The crucial importance of accurate supporting measurements and the limitations of present diagnostics for making the needed measurements of local plasma potential and magnetic field has led an increased emphasis on R & D for new and better diagnostics for this application. This paper reviews the diagnostic instruments and ideas presented at the "Joint U.S. - Japanese workshop on Local Plasma Potential and Magnetic Field Measurements," held at the Lawrence Livermore National Laboratory in Sept. 1984. While emphasis in this workshop was on the local potental measurements that are so crucial to the understanding and control of the potential profile of high-temperature confinement systems such as tandem mirrors with thermal electron barriers, extensive discussion of techniques for local measurement of magnetic fields, particularly with probe beams of various kinds, was included.

39348 **Recent experiments on a magnetically insulated ion diode with an active anode plasma source.** Greenly, J.B.; Ueda, M.; Rondeau, G.D. (Cornell Univ.). pp 2R-4 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC02-77ET53005.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The puff valve used in the previous experiments gave uniformity worse than a factor of two in the azimuth and had a tendency to degrade with time. Therefore a new puff valve has been developed and incorporated into the diode. Puffed gas measurements show that better than 15% uniformity is now obtained and there is no sign of puff degradation with time. The term plans include: optimization of the plasma source with the new puff valve, pursuing uniform plasma output while maintaining or improving upon all the qualities obtained previously. In addition, we will diagnose beam optics and magnetic bending in the diode insulating field to attempt a determination of the anode plasma position in the gap as well as its shape. The extracted beam species is characterized.

39349 **Operation of the multicusp plasma generator as a high-charge-state ion source.** Leung, K.N.; Pyle, R.V. (Lawrence Berkeley Lab., Berkeley, CA). pp 4P-4 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC03-76SF00098.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

It has been demonstrated that permanent magnets can be used to improve the density and uniformity of DC discharge plasmas. In recent years, there has been a growing interest in applying these multicusp plasma generators as ion sources for neutral beam injection systems. In order to form energetic neutral beams from H^- or D^- ions, a compact and efficient neutralizer is desired. A high charge state plasma target may become a good candidate for this application. Attempt has been made to operate a "closed" multicusp plasma generator as a source of high charge state ions. The prototype source is fabricated from an oxygen-free copper cylinder (15 cm diam by 20 cm long) which is surrounded externally by 8 columns of samarium-cobalt magnets to form a longitudinal line-cusp configuration. In normal operation, the argon pressure inside the source is maintained at $\simeq 5 \times 10^{-5}$ Torr. Preliminary results show that the source is capable of producing positive argon ions with charge state as high as +7 (average charge state is between 2

and 3) for a discharge power of 250 V and 25 A. Different schemes to enhance the high charge state ions is presented.

39350 **MHD stability properties of shaped toroidal configurations.** Johnson, J.L. (Princeton Univ., Plasma Physics Lab., Princeton, NJ). pp 3S-1 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC02-76CH03073.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The favorable confinement results observed on tokamaks has led to the belief that it will lead to the first demonstration of scientific feasibility of magnetic fusion. Considerable data has been assembled which indicates that tokamak operation is limited to the β-values (β is the ratio of material pressure confined to magnetic pressure) below a limit set by ideal MHD instabilities such as ballooning and external kink modes. The stability limits for these modes depend strongly on the shape of the plasma column. Recently, β-values of five per cent have been achieved on PBX, the Princeton Beta Experiment. Many of the high-β shots end in plasma disruptions. Some understanding is now being generated on the relation between high-n ballooning modes and low-n kink and tearing instabilities. This should provide insight into the way plasma shaping can lead to even higher-β operation. In order to obtain the favorable stability properties of bean-shaped tokamaks with respect to ballooning modes, it is necessary to maintain a broad current profile. This, in turn, makes stabilization of low-n free-boundary modes difficult. An obvious solution to this problem would be to introduce the rotational transform by means of external fields as in a stellarator, which would eliminate the need for a net toroidal current in the plasma. Favorable experimental progress, together with optimistic theoretical predictions, has recently rekindled interest in the stellarator approach. Heliotron-E has been operated with β-values of two per cent, significantly higher than that predicted by simple theory. Current thinking in this program, together with its present status, is discussed.

39351 **Octopole and hexapole end cells for tandem mirrors.** Devoto, R.S. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA). pp 2P-2 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract W-7405-ENG-48.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

To date, nearly all operating or planned tandem mirror experiments use quadrupole magnetic fields in the end cells for stabilization of magnetohydrodynamic (MHD) instabilities. A disadvantage with quadrupole fields is the considerable aximuthal asymmetry in the magnetic field. As a result, those center-cell ions which pass into the end cell can suffer a radial deflection and be lost by radial diffusion. The diffusion can be minimized by adding C-coils to the end cell to symmetrize the geodesic curvature in the end cell. Very small radial deflection can be obtained on each field line. Such a method is used in the design of the MFTF-B experiment and the MARS reactor. A disadvantage of this approach is the large number of coils required. In addition, since ions drift azimuthally as they reflect in the end cell, even perfect cancellation on individual field lines will, in general, not lead to zero radial diffusion. One way to form a more symmetric field in the end cells is to use multipoles higher than quadrupole. The use of an octopole end cell for a small tandem-mirror reactor was recently proposed/sup L/ and has been adopted for the miniMARS reactor study. In this paper the author discusses some feature of octopole, and to a lesser extent, hexapole end cells in both reactor and experimental (MFTF-B) applications.

39352 **Estimation of linear and quadratic transfer fuctions for fully developed turbulence.** Ritz, CH.P.; Powers, E.J. (Univ. of Texas at Austin, Austin, TX 78712). pp 3C-5 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC05-78ET53043.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

A statistical method for modeling the linear and quadratically nonlinear relationship between fluctuations monitored at two spatial points in a turbulent medium is presented. This relationship is described with the aid of linear and quadratic transfer functions. For this work the authors study a system which can be described by a single input and output and which shall be modeled in the frequency domain by linear and quadratic elements. A unique feature of the approach described in this paper is that it is valid for non-Gaussian "input " and "output" signals. The relaxation of the assumption of a Gaussian input permits studies of self-excited turbulent systems such as in fluids and plasma. The concept of coherency is extended to quantify the goodness of the quadratic model.

39353 **Ballooning spectrum of rotating plasmas.** Hameiri, E.; Laurence, P. (New York Univ., NY). *Studies in Applied Mathematics;* **25**: No. 2, 396-405(Feb 1984). Contract AC02-76ER03077.

Ballooning modes are shown to be part of the spectrum by using a singular sequence of localized modes. It is shown that the modes arise from Alfven and slow magnetosonic waves propagating along rays confined inside the plasma. Different ballooning modes are seen, depending on the particular rotating frame of observation, indicating that there are accumulation points of eigenvalues. The effect of rigidly rotating flow is seen to be destabilizing due to an analog of the Rayleigh-Taylor instability associated with density gradients in the presence of a centrifugal force. Flow shear also modifies the stability criterion. A certain component of the flow shear will eliminate the ballooning modes. 17 references.

39354 **X-ray diagnostics of tokamak plasmas.** Kaellne, E.; Kaellne, J. (Harvard-Smithsonian Astrophysical Observatory, Cambridge, MA). *AIP (American Institute of Physics) Conference Proceedings;* No. 94, 463-479(1982). (CONF-820855—).

From International conference on X-ray and atomic inner-shell physics; Eugene, OR, USA (23 Aug 1982).

In this review, the authors venture into a new arena for work in atomic X-ray spectroscopy which can be dubbed tokamak X-ray spectroscopy diagnostics (TOXRASD). Not only is the experimental development exciting, but the measurements explore areas of atomic and plasma physics which have been inaccessible until just recently. Even though much of the present experimental effort is oriented towards obtaining a TOXRASD for fusion conditions, the new results touch upon some very basic atomic physics questions as well. Much effort has gone into the study of few electron systems, i.e., H-, He-, and Li-like ions with the purpose of utilizing the characteristic X-ray emission for diagnosing laboratory and astronomical plasmas or with the aim of developing the diagnostics, i.e., extending our understanding of the relationship between X-ray line emission and the plasma conditions under which the ions are formed and their ground states excited. However, the emission from highly charged heavy ions, such as neon-like molybdenum, has also attracted interest. Here the focus of the discussion is around results of the latest vintage from the TOXRASD project at the Alcator C tokamak at MIT. 38 references, 14 figures.

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REFER ALSO TO CITATION(S) 38229, 38291, 38396, 38404, 38443, 38444, 38581, 38617, 38618, 39074, 39322, 39324, 39344

39355 **(CONF-860166—4) Muon-induced fusion: experiments at LAMPF.** Jones, S.E. (Brigham Young Univ., Provo, UT (USA). Dept. of Physics and Astronomy). 1986. Contract FG02-85ER13449. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86011483.

From Workshop on fundamental muon physics: atoms, nuclei, and particles; Los Alamos, NM, USA (20 Jan 1986).

LAMPF Experiment No. 727, a study of muon-catalyzed fusion in mixtures of deuterium and tritium, was started in 1982 and completed with several important extensions in 1985. A unique feature of the experiment was that near-liquid-hydrogen densities were maintained over a broad range of temperatures. Many basic param-

eters of muon catalysis were measured for the first time. A summary is given of salient results with an emphasis on the many surprises that the experiment yielded.

39356 (CONF-860421—56) Isotopic alloying to tailor helium production rates in mixed-spectrum reactors. Mansur, L.K.; Rowcliffe, A.F.; Grossbeck, M.L.; Stoller, R.E. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012232.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

The insoluble inert gas helium has been found to produce significant changes in the irradiation response of structural materials when introduced at levels in the appm range and above. In the structural materials for future fusion reactors, (n,α) transmutation reactions induced at a high rate by the 14 MeV component of the neutron spectrum will lead to helium production rates of the order of 10 appm/dpa. However, until a fusion reactor is available, materials scientists must study radiation effects, including the interactions with helium, by means of accelerator and fission reactor irradiations.

39357 (CONF-860652—6) Folded waveguide coupler for ion cyclotron heating. Owens, T.L.; Chen, G.L. (McDonnell Douglas Astronautics Co., St. Louis, MO (USA); Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012230.

From 7. topical meeting on the technology of fusion energy; Reno, NV, USA (15 Jun 1986).

A new type of waveguide coupler for plasma heating in the ion cyclotron range of frequencies is described. The coupler consists of a series of interleaved metallic vanes within a rectangular enclosure analogous to a wide rectangular waveguide that has been "folded" several times. At the mouth of the coupler, a plate is attached which contains coupling apertures in each fold or every other fold of the waveguide, depending upon the wavenumber spectrum desired. This plate serves primarily as a wave field polarizer that converts coupler fields to the polarization of the fast magnetosonic wave within the plasma. Theoretical estimates indicate that the folded waveguide is capable of high-efficiency, multimegawatt operation into a plasma. Bench tests have verified the predicted field structure within the waveguide in preparation for high-power tests on the Radio Frequency Test Facility at the Oak Ridge National Laboratory.

39358 (CONF-860652—7) Liquid nitrogen cooling considerations of the compact ignition tokamak. Dabiri, A.E. (Oak Ridge National Lab., TN (USA)). 15 Jun 1986. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012620.

From 7. topical meeting on the technology of fusion energy; Reno, NV, USA (15 Jun 1986).

An analytical procedure was developed to estimate the cooldown time between pulses of the Compact Ignition Tokamak (CIT) utilizing liquid nitrogen. Fairly good agreement was obtained between the analysis results and those measured in the early fusion experimental devices. The cooldown time between pulses in the CIT is controlled by the energy disposition in the inner leg of the TF coil. A cooldown time of less than one hour is feasible for the CIT if fins are used in the cooling channels. An R and D experimental program is proposed to determine the actual cooldown time between pulses since this would be considered an issue in the conceptual design of the CIT.

39359 (CONF-8604212—1) CIT cost review for external remote maintenance equipment (WBS K). Spampinato, P.T. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011756.

From CIT cost review meeting; Princeton, NJ, USA (23 Apr 1986).

Viewgraphs from the presentation are included. (MOW)

39360 (CONF-8605139—2) Minimars configuration design. Lousteau, D.C. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86011783.

From Minimars review meeting; Toronto, Canada (20 May 1986).

Viewgraphs are presented on the various Minimars assemblies. (MOW)

39361 (DOE/ER/53198—95) University of Wisconsin reversed field pinch boundary study. Quarterly progress report, March 13-June 13, 1986. Dexter, R.N.; Prager, S.C.; Sprott, J.C. (Wisconsin Univ., Madison (USA)). 1986. Contract FG02-85ER53198. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012666.

This report summarizes our progress during the fifth quarter of support of our RFP boundary study. We obtained bids on the first and major portion of the finish-machining of the vacuum containment vessel, and signed contracts with Sulzer the representatives of de Pretto-Escher Wyss (the VCV fabricator) to proceed. The Physics group agreed on the engineering features of the final machining which await only final drawings. Our Engineering Manage visited de Pretto-Escher Wyss in Italy and inspected the fabrication to this point, having also examined the work schedule, which remains compatible with the original goals. We continued to obtain improvement in the RFP plasmas created in the Octupole tank which reached reliable operation at the 300 kA level. Data sets on fluctuation measurements were obtained for wide ranges of q, from tokamak to RFP regimes. Our new data acquisition hardware and software were installed and tested. Major orders for vacuum equipment were completed. Major agreements on remodeling plans, and crane modifications were accomplished. The 1:8-scale wooden model was brought up to date. Programmatic tests of toroidal rail-limiters were initiated. Arc segments were fabricated for final welding of the optimized hoops, which we now plan to install early in August 1986.

39362 (LA-UR—86-2045) Directions for reactor target design based on the US heavy ion fusion systems assessment. Wilson, D.C.; Dudziak, D.; Magelssen, G.; Zuckerman, D.; Dreimeyer, D. (Los Alamos National Lab., NM (USA); McDonnell Douglas Astronautics Co., St. Louis, MO (USA)). 1986. Contract W-7405-ENG-36. 12p. (CONF-8606131—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012415.

From 2. international topical symposium on ICF research by high-power beams; Nagaoka, Japan (16 Jun 1986).

We studied areas of major uncertainty in target design using the cost of electricity as our figure of merit. Net electric power from the plant was fixed at 1000 MW to eliminate large effects due to economies of scale. The system is relatively insensitive to target gain. Factors of three changes in gain cause only 8 to 12% changes in electricity cost. An increase in the peak power needed to drive targets poses only a small cost risk, but requires many more beamlets be transported to the target. A shortening of the required ion range causes both cost and beamlet difficulties. A factor of 4 decrease in the required range at a fixed driver energy increases electricity cost by 44% and raises the number of beamlets to 240. Finally, the heavy ion fusion system can accommodate large increases in target costs. To address the major uncertainties, target design should concentrate on the understanding requirements for ion range and peak driver power.

39363 (SAND—85-2628C) Trapping of deuterium in oxygen-implanted aluminum. Myers, S.M.; Follstaedt, D.M. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 15p. (CONF-860522—15). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012165.

From 7. international conference on plasma surface interactions in controlled fusion devices; Princeton, NJ, USA (5 May 1986).

Temperature-ramp experiments employing nuclear-reaction analysis have shown that deuterium (D) is strongly trapped by Al_2O_3 precipitates in O-implanted Al. Binding enthalpies of approximately 0.7 and 1.2 eV relative to the solution site were ob-

tained for the oxide-associated traps, as compared to 0.5 eV for defect traps within the metal matrix. The 0.7-eV trapping is hypothesized to result from the formation of D_2 molecules at the oxide boundaries and possibly within the oxides, whereas the 1.2-eV interaction is tentatively attributed to O-D bonding. Strong trapping of hydrogen isotopes by oxides within Al and possibly other metals has significant implications for plasma-materials interactions in fusion reactors.

39364 **(SAND—86-0962C) Nuclear microprobe analysis. Applications.** Doyle, B.L. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 20p. (CONF-860829—20). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009637.

From Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society; Albuquerque, NM, USA (10 Aug 1986).

Nuclear microprobe analysis is a relatively small, but growing, field which utilizes high energy (MeV) beams of finely focused (1 μm) ions to examine the atomic composition of the near-surface region of solids. With this analytic technique, every element in the periodic table is detectable, for most cases at trace amounts, and for many cases concentrations can be nondestructively determined in three dimensions. The emphasis of this paper will be to give examples of how a nuclear microprobe can be applied to a materials problem. A recent study of TiC-coated graphite tiles used in the main moveable limiter in the Tokamak Fusion Test Reactor (TFTR) at Princeton Plasma Physics Laboratory was selected as the central topic of this paper, because most of the ion beam analysis techniques which are available on our probe were used in this investigation.

39365 **(UCRL—93763) Parametric economic studies for inertial confinement fusion electric power plants.** Meier, W.R.; Hogan, W.J. (Lawrence Livermore National Lab., CA (USA)). 11 Jun 1986. Contract W-7405-ENG-48. 12p. (CONF-860601—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012188.

From 4. international conference on emerging nuclear energy systems; Madrid, Spain (30 Jun 1986).

We have conducted parametric economic studies for inertial confinement fusion (ICF) electric power plants using an economic model to estimate the cost of electricity. We found that the economy of scale of the reactor is an important factor in determining the combination of target gain, driver efficiency, and electric conversion efficiency required for an economically competitive system. A strong economy of scale allows a significant reduction in these performance parameters for a given cost of electricity. The degree of reduction is dependent, however, on the maximum achievable chamber pulse rate.

39366 **(UCRL—93848) Standard method for economic analyses of inertial confinement fusion power plants.** Meier, W.R. (Lawrence Livermore National Lab., CA (USA)). 30 May 1986. Contract W-7405-ENG-48. 18p. (CONF-860610—28). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012356.

From American Nuclear Society annual meeting; Reno, NV, USA (15 Jun 1986).

A standard method for calculating the total capital cost and the cost of electricity for a typical inertial confinement fusion electric power plant has been developed. A standard code of accounts at the two-digit level is given for the factors making up the total capital cost of the power plant. Equations are given for calculating the indirect capital costs, the project contingency, and the time-related costs. Expressions for calculating the fixed charge rate, which is necessary to determine the cost of electricity, are also described. Default parameters are given to define a reference case for comparative economic analyses.

39367 **(UCRL—94097) Wolter x-ray microscope calibration.** Gerassimenko, M. (Lawrence Livermore National Lab., CA (USA)). Jun 1986. Contract W-7405-ENG-48. 6p. (CONF-860880—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86012340.

From 30. SPIE technical symposium on optics and optoelectronic engineering; San Diego, CA, USA (17 Aug 1986).

A 22 x Wolter microscope was calibrated after several months of operation in the Lawrence Livermore National laboratory (LLNL) Inertial Confinement Fusion program. Placing a point x-ray source at the microscope focus, I recorded the image plane spectrum, as well as the direct spectrum, and from the ratio of these two spectra derived an accurate estimate of the microscope solid angle in the 1 to 4 keV range. The solid angle was also calculated using the microscope geometry and composition. Comparison of this calculated value with the solid angle that was actually measured suggests contamination of the microscope surface.

39368 **(UCRL—94335) Economic studies for heavy-ion-fusion electric power plants.** Meier, W.R.; Hogan, W.J.; Bangerter, R.O. (Lawrence Livermore National Lab., CA (USA)). 20 May 1986. Contract W-7405-ENG-48. 10p. (CONF-860510—7). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012192.

From Symposium on heavy ion fusion; Washington, DC, USA (27 May 1986).

We have conducted parametric economic studies for heavy-ion-fusion electric power plants. We examined the effects on the cost of electricity of several design parameters: cost and cost scaling for the reactor, driver, and target factory; maximum achievable chamber pulse rate; target gain; electric conversion efficiency; and net electric power. Using the most recent estimates for the heavy-ion-driver cost along with the Cascade reactor cost and efficiency, we found that a 1.5 to 3 GWe heavy-ion-fusion power plant, with a pulse rate of 5 to 10 Hz, can be competitive with nuclear and coal power plants.

39369 **(UCRL—94608) Fusion breeder blanket nucleonics.** Lee, J.D. (Lawrence Livermore National Lab., CA (USA)). 20 Jun 1986. Contract W-7405-ENG-48. 4p. (CONF-860601—5). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012352.

From 4. international conference on emerging nuclear energy systems; Madrid, Spain (30 Jun 1986).

Refined nuclear analysis, including the treatment of resonance and spatial self-shielding, coupled with an optimization procedure, has resulted in improved performance estimates for two conceptual fission-suppressed blankets. Net specific breeding in these two blankets maximized at 0.024 and 0.023 U-233 atoms/MeV, which is about an order of magnitude higher than in fission breeders.

39370 **(UCRL—94609) MINIMARS: a 600-MWe advanced mirror-fusion reactor design.** Lee, J.D.; Logan, B.G. (Lawrence Livermore National Lab., CA (USA)). 20 Jun 1986. Contract W-7405-ENG-48. 4p. (CONF-860601—4). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012353.

From 4. international conference on emerging nuclear energy systems; Madrid, Spain (30 Jun 1986).

MINIMARS is a conceptual fusion reactor based on tandem-mirror magnetic confinement. It is designed to produce 600 MW net electric for 41 mils/kWh and to be capable of passive shutdown and afterheat removal.

39371 **Applied-B-italic ion diode experiments on the Particle Beam Fusion Accelerator-I.** (Sandia National Laboratories, P.O. Box 5800, Albuquerque, New Mexico). *Journal of Applied Physics;* 60: No. 3, 878-897(1 Aug 1986). Contract AC04-76DP00789.

A series of experiments was performed with an Applied-B-italic ion diode on the Particle Beam Fusion Accelerator-I, with peak voltage, current, and power of approximately 1.8 MV, 6 MA, and 6 TW, respectively. The purpose of these experiments was to explore issues of scaling of Applied-B-italic diode operation from the sub-TW level on single module accelerators to the multi-TW level on a low impedance, self-magnetically insulated, multimodule accelerator. This is an essential step in the development of the 100-TW level light ion beam driver required for inertial confinement fusion. The accelerator and the diode are viewed as a whole because the power pulse delivered by the 36 imperfectly synchronized magnetically insulated transmission lines to the single diode affects module addition, diode operation, and ion beam focusability. We

studied electrical coupling between the accelerator and the diode, power flow symmetry, the ionic composition of the beam, and the focusability of the proton component of the beam. Scaling of the diode impedance behavior and beam quality with electrical drive power is obtained from comparison with lower-power experiments.

39372 Illumination uniformity of laser-fusion pellets using induced spatial incoherence. Schmitt, A.J.; Gardner, J.H. (Naval Research Laboratory, Washington, DC 20375). *Journal of Applied Physics;* **60**: No. 1, 6-13(1 Jul 1986).

We have examined the possibility of using a realistic laser system to produce uniform illumination of a direct drive laser-fusion pellet. This laser system consists of a short wavelength laser (KrF, $\lambda = 0.25$ μm) with the induced-spatial-incoherence method. A numerical analysis describes the laser beams propagating through the pellet plasma, energy deposition by inverse bremmstrahlung absorption, and energy conversion to ablation drive pressure. The results indicate that highly uniform ($\Delta P/<P><2\%$) distributions can be produced while a large fraction of the laser beam energy (>75%) is simultaneously absorbed. The spatial structure of the distribution is also analyzed and found to contain primarily low spatial frequencies with maximum magnitudes less than 0.5%. Misalignment of the laser beams increases the overall nonuniformity by about 1.5% for every 1% increase in the relative misaiming error (measured as a percentage of the pellet radius). A maximum misalignment error on the order of a few microradians in the final optics is suggested by this analysis.

39373 Magnetic field alignment studies for the URAGAN-3 torsatron. Colchin, R.J.; Harris, J.H.; Lee, D.K.; Rome, J.A.; Fedotov, S.I.; Ozherel'ev, F.I.; Pavlichenko, O.S.; Pogozhev, D.P.; Zalkind, V.M.; Treffert, J.D. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Review of Scientific Instruments;* **57**: No. 7, 1233-1241(Jul 1986). Contract AC05-84OR21400;AC02-84ER53166.

If the major axes of the helical and vertical field coils of a torsatron plasma confinement device are not aligned to within ~ 1% of their major radii, the resulting error field can break up closed magnetic flux surfaces and reduce the effective plasma confinement volume. A novel technique for accurately locating the magnetic symmetry axes of torsatron helical and vertical coil sets to within ~ 1 mm using magnetic field measurements near the device major axis (i.e., away from the confinement volume) is described and applied to the URAGAN-3 torsatron. The axis of the vertical field coil set was found to be shifted by ~ 1 cm relative to the axis of the helical coil set; this shift could account for the reduced confinement volume observed in previous experiments. The magnetic measurements were repeated after coil repositioning to verify correct alignment.

39374 Radio frequency induction plasma generator 80-kV test stand operation. Goede, H.; DiVergilio, W.F.; Fosnight, V.V.; Vella, M.C.; Ehlers, K.W.; Kippenhan, D.; Pincosy, P.A.; Pyle, R.V. (TRW Space and Technology Division, Redondo Beach, California 90278). *Review of Scientific Instruments;* **57**: No. 7, 1261-1265(Jul 1986). Contract AC03-76SF00098;AC03-81ER52071.

Beam extraction tests at energies up to 80 kV were performed using a radio frequency induction (RFI) plasma generator hydrogen ion source. A 7 x 10-cm², long pulse accelerator was operated with a 10 x 10-cm² axial magnetic cusp bucket and a magnetic-filter bucket. Atomic fractions (up to 85% H^+), plasma production efficiencies (roughly-equal0.6 A of beam per kW rf power), and beam divergence were at least as good as with arc plasmas in similar chambers. Potential advantages of the RFI plasma sources for large-scale applications are ease of operation, reliability, and extended service life.

39375 Particle and impurity control in toroidal fusion devices. (Fusion Research Center, The University of Texas at Austin, Austin, Texas 78712). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 4, 1918-1932(Jul 1986).

A review of working particle and impurity control techniques used in and proposed for magnetic fusion devices is presented. The requirements of both present-day machines and envisaged fusion reactors are considered. The various techniques which have been proposed are characterized by whether they affect sources, sinks, or fluxes; in many cases a particular method or device can appear in more than one category. Examples are drawn from published results. The solutions proposed for the large devices which will be operating during the next 5 years are discussed.

39376 Cleanup and gettering during the Beryllium Limiter Experiment in Impurity Study Experiment-B. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* **4**: No. 4, 1933-1938(Jul 1986). Contract AC05-84OR21400.

Changes in plasma impurities and radiated power due to cleanup and gettering during the Beryllium Limiter Experiment are related to changes of the surface composition of the torus walls and residual gases in the torus. Pulse discharge cleaning was very effective in cleaning the ISX-B vacuum vessel after installation of the beryllium limiter. As a result of discharge cleaning, areas near the limiter were soon covered with a beryllium rich deposit containing some iron, nickel, chromium, and titanium as well as oxygen, carbon, sulfur, and nitrogen. Oxygen levels on the wall were reduced to below 10 at. %. Materials transport during discharge cleaning was apparently due to sputtered neutrals. Evaporation of beryllium from the limiter and subsequent deposition on the torus walls caused by high power tokamak shots produced gettering of the machine equal or better than that previously obtained with titanium or chromium. This gettering by beryllium eliminated the need for further discharge cleaning or other gettering. Beryllium transport in this case appears to be mostly as ions in the plasma edge.

39377 Design of an air-core reversed field pinch. Schmid, P.; Robertson, S. (Dept. of Physics, Univ. of Colorado, Boulder, CO 80309). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 3, 267-270(Jun 1986).

The design of a small air-core reversed field pinch (RFP) is described. A numerical model was used to simulate the waveform of the plasma current and to improve the design of the air-core transformer.

39378 Analysis of dielectric-filled waveguide coupling to plasmas in the ICRF. Lam, N.T.; Lee, J.L.; Scharer, J.; Vernon, R.J. (Dept. of Electrical and Computer Engineering, Univ. of Wisconsin, Madison, WI 53706). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-14**: No. 3, 271-276(Jun 1986).

Dielectric-filled waveguides may be advantageous for heating reactor-grade tokamak plasmas, due to their compactness and power-handling capability. The authors present a theoretical analysis of coax excitation and plasma impedance for a dielectric-filled rectangular waveguide. The plasma reflection coefficient is obtained by matching plasma and waveguide fields at the interface. The numerical results show that the reflection coefficients can be made small by careful tailoring of the waveguide dimensions to the density profile for heating at the second or third harmonic of deuterium. They present a scattering matrix approach for the design of a coaxial feed to match the waveguide in the presence of a wide range of plasma loading. For a waveguide filled with a high permittivity dielectric, a shorted probe gives better coupling than an open-ended probe.

39379 High—aspect-ratio laser-fusion targets driven by 24-beam uv laser radiation. Richardson, M.C.; McKenty, P.W.; Keck, R.F.; Marshall, F.J.; Roback, D.M.; Verdon, C.P.; McCrory, R.L.; Soures, J.M.; Lane, S.M. (Laboratory for Laser Energetics, University of Rochester, 250 East River Road, Rochester, New York 14623-1299). *Physical Review Letters;* **56**: No. 19, 2048-2051(12 May 1986). Contract FC08-85DP40200.

The implosions of thin-walled, large-diameter, deuterium-tritium—filled glass microballoon targets ablatively driven by the 351-nm, 2-kJ OMEGA laser are reported. Compressed fuel diagnostics, including the first direct simultaneous measurements of the fuel and

shell areal densities, and detailed hydrodynamic simulations determine the effect of illumination uniformity on implosion symmetry.

39380 The elusive isobaric reactor. Mills, R.G. (Princeton Univ., Dept. of Chemical Engineering, School of Engineering and Applied Science, Princeton, NJ 08544). *Fusion Technology;* 9: No. 3, 408-421(May 1986).

A reactor is proposed in which the principal role of the magnetic field is to reduce the thermal conductivity. A purely toroidal magnetic field confines a plasma whose pressure is almost constant. The plasma is limited in height by two planar electrodes. The density rises as the temperature falls toward the material boundaries to maintain essentially isobaric conditions. Fueling the reactor is a simple by-product of the drift motion of the ions through the reactor, the confinement time being determined by the residence time of transport rather than by diffusion. As in many reactor schemes, the size is large, but not unreasonable. There are unsolved problems requiring research, but these seem addressable with modest temperature plasmas.

39381 Conceptual design of a deuterium-^{3}He fueled tandem mirror reactor satellite/breeder system. Shuy, G.W.; Dabiri, A.E.; Gurol, H. (Science Applications International Corp., La Jolla, CA 92038). *Fusion Technology;* 9: No. 3, 459-475(May 1986).

The purpose of this paper is to describe and assess a system of "nearly" neutron-free fusion reactors and their fuel breeding source. This breeder is a fusion reactor that produces ^{3}He for the "satellite" reactors. In this study the breeder is a self-sustaining fuel production plant, that is, it neither contributes to the power grid system nor consumes any power from the grid system. The assessment is made with respect to physics, engineering, cost, and safety.

39382 A parametric study of water-cooled solid breeder blanket designs. Misra, B.; Morgan, G.D. (Argonne National Lab., 9700 South Cass Avenue, Argonne, IL 60439). *Fusion Technology;* 9: No. 3, 452-458(May 1986).

An assessment of the role of the design and operating parameters on the performance of solid breeder blankets based on lithium ceramics (Li_2O and γ-$LiAlO_2$) was carried out. The results indicate that not only poor thermophysical properties but also uncertainties associated with the property data base are the design-limiting factors. In addition, the operating conditions such as the upper and the lower temperature limits, the choice of breeder materials either in the form of sintered pellets or in sphere-pac form, the interfacial contact resistance between the coolant channels and the solid breeder, and the diffusion characteristics of tritium and chemical interactions between tritium and the solid breeder play a prominent role in selection of blanket concepts. Designs to account for the expected degradation of the thermophysical properties due to thermal sintering and nuclear irradiation lead to high coolant and structural material fractions, and thus may result in a lower tritium breeding ratio. The results of the parametric studies show that water-cooled solid breeder blanket designs require a firmer data base for the operating temperature limits, the thermophysical properties, the gap conductances, and the tritium retention and release characteristics of solid breeders.

39383 Pulse discharge cleaning for open-ended systems. Garner, H.R.; Aoki, T. (GA Technologies, Inc., P.O. Box 85608, San Diego, CA 92138). *Fusion Technology;* 9: No. 3, 481-483(May 1986).

A significant improvement in plasma parameters (ion temperature and electron temperature) has been achieved through the use of pulse discharge cleaning in the mirror machine, RFC-XX-M, in Nagoya, Japan. The essence of this technique is to use pulsed-off-resonance ion cyclotron heating (10-ms duration every 10 s), gas puffing, and electron cyclotron heating preionization in conjunction with baking (to 100 to 150°C) in order to prepare the machine surfaces for full-power normal experimental shots. It was also found that RFC-XX-M could operate at nearly full parameters without titanium gettering after discharge cleaning, whereas without discharge cleaning and titanium gettering it is difficult to sustain a plasma.

39384 The performance of the poloidal divertor experiment neutral beam wall armor. Kugel, H.W.; Eubank, H.P.; Kozub, T.A.; Williams, M.D.; Ulrickson, M. (Plasma Physics Lab., Princeton Univ., Princeton, NJ 08544). *Fusion Technology;* 9: No. 3, 401-407(May 1986).

During 2 yr of experimental operations, the Poloidal Divertor Experiment (PDX) inner wall neutral beam graphite armor provided protection for perpendicular heating injections into normal and disruptive plasmas as well as injection in the absence of plasma for special experiments, calibrations, and tests involving the optimization and development of the PDX neutral beam injection system. About 80 to 100 heating injections occurred per operating day, at a 360-s duty cycle, into plasmas of various densities, and typically $\approx$5 to 50% of the injected neutral beam power was transmitted to the armor. More than 10^3 neutral beam pulses of 100- to 300-ms duration were injected in the absence of plasma at peak power densities of 1.5 to 3 kW/cm^2, yielding peak surface temperatures of 950 to 1550°C. There was no significant impurity production attributable to beam heating of the armor, and no observed beam-induced, macroscopic surface damage. Many of the design constraints and performance issues encountered in this work are relevant to the design of larger fusion devices.

39385 Inertial confinement fusion development options: Facility characteristics and schedules from a reactor physics viewpoint. Blink, J. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA 94550). *Fusion Technology;* 9: No. 3, 381-390(May 1986). Contract W-7405-ENG-48.

The pulsed, localized fusion source in inertial confinement fusion (ICF) permits scale-down of reactor dimensions and fusion yield in development facilities while still maintaining full-scale reactor surface and volume energy loads. Hence, the power and geometric scale of ICF development facilities can be much smaller than comparable magnetic fusion facilities. The power is reduced by reducing both the pulse rate and the target gain; however, full gain and pulse rate experiments of limited duration will be possible. At least three engineering facilities will be required for the development of heavy-ion beam or short wavelength laser driven fusion power. The design and construction times required for large facilities produce a nominal plan with a demonstration (DEMO) plant operating around the year 2018, and a crash plan with DEMO operation in 2009. Fusion breeder development is expected to follow a similar time line, except that a crash (option-limited) plan could succeed as early as the turn of the century.

39386 Tokamak Fusion Test Reactor gas injection control system design and operation. Thompson, M.E.; Dylla, H.F.; LaMarche, P.H.; Arnold, N.D.; Rauch, W.A.; Mueller, D.; Hawryluk, R.J. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey, 08544). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 317-321(May 1986). Contract AC02-76CH03073.

Magnetic fusion devices require fast-responding, versatile, and accurate gas injection systems in order to initiate and modulate the plasma density. We describe the gas injection control system (GICS), which regulates the gas injected into the torus of Princeton's Tokamak Fusion Test Reactor (TFTR). Synchronized with each TFTR discharge, a PDP 11/23 microcomputer provides real-time control for one to six fast injection valves, each allocated to feedback or open loop operation. Up to four feedback sources, including torus pressure gauges and plasma density measurements, are checked once each cycle for 1000 cycles; the cycle duration can be set to any multiple of 2 ms up to 16 ms. Detection of various fault conditions can cause automatic shutdown or modification of GICS operation. Data is archived after each TFTR discharge, and subsequently used for particle fueling studies and analysis of system drifts. A steady state mode of operation is used for vacuum vessel discharge cleaning. The system also provides for valve calibration and torus pumping speed measurements.

39387 Neutral beam injection induced gas influx and desorption in the Doublet III vessel. Kim, J.; Colleraine, A.P.; Stewart, L.D. (GA Technologies, Inc., San Diego, California 92138). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1084-1086(May 1986). Contract AC03-84ER51044.

A method is presented of determining the gas flow from a beamline to a tokamak vessel and the gas desorption due to neutral beams impinging upon the torus wall. Time-dependent gas pressure measured both in the beamline and in the torus are matched by the corresponding theoretical solutions to arrive at unique values of the conductance between the two volumes, the desorption rate, and the pumping speed. This technique has been successfully demonstrated on the Doublet III tokamak and its beamlines.

39388 Hydrogen pellet acceleration with a two-stage system consisting of a gas gun and a fuseless electromagnetic railgun. Honig, J.; Kim, K.; Wedge, S.W. (Department of Electrical and Computer Engineering, University of Illinois, Urbana, Illinois 61801). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1106-1112(May 1986).

Hydrogen pellets are successfully accelerated for the first time using a two-stage system consisting of a pneumatic gun and an electromagnetic railgun. The pneumatic gun preaccelerator forms cylindrical hydrogen ice pellets (1.6-mm diam x 2.15-mm long) and accelerates them with high-pressure helium gas to velocities in excess of 500 m/s. The booster accelerator, which is a fuseless, circular-bore electromagnetic railgun, derives its propulsive force from a plasma arc armature. The plasma arc armature is formed by electrically breaking down the propellant gas which follows the pellet from the gas gun into the railgun. The diagnostics are for the monitoring of the main capacitor bank and rail currents, for the pellet detection and velocity measurements at the breech and muzzle ends of the railgun, for the recording of the plasma-arc-armature movement inside the railgun bore, and for the photographing of the hydrogen pellet exiting the railgun. Using the system, which is a 60-cm long proof-of-principle machine for refueling magnetic fusion devices, hyrogen pellet velocities exceeding 1 km/s have been achieved for pellets exiting the gas gun at velocities of ~500 m/s.

39389 Operation of a repeating pneumatic hydrogen pellet injector on the Tokamak Fusion Test Reactor. Combs, S.K.; Milora, S.L.; Foust, C.R.; Schmidt, G.L.; McBride, T.P. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1113-1117(May 1986). Contract AC05-84OR21400.

The repeating pneumatic hydrogen pellet injector, which was developed at the Oak Ridge National Laboratory (ORNL), has been installed and operated on the Tokamak Fusion Test Reactor (TFTR). The injector combines high-speed extruder and pneumatic acceleration technologies to propel frozen hydrogen isotope pellets repetitively at high speeds. The pellets are transported to the plasma in an injection line that also serves to minimize the gas loading on the torus; the injection line incorporates a fast shutter valve and two stages of guide tubes with intermediate vacuum pumping stations. A remote, stand-alone control and data acquisition system is used for injector and vacuum system operation. In early pellet fueling experiments on TFTR, the injector has been used to deliver deuterium pellets at speeds ranging from 1.0 to 1.5 km/s into plasma discharges. First, single large (nominal 4 mm diam) pellets provided high densities in TFTR (1.8×10^{14} cm^{-3} on axis); after conversion to smaller (nominal 2.7 mm diam) pellets, up to five pellets were injected at 0.25 s intervals into a plasma discharge, giving a line-averaged density of 1×10^{14} cm^{-3}. Operating characteristics and performance of the injector in initial tests on TFTR are presented.

39390 Nuclear spin polarization of solid deuterium—tritium. Souers, P.C.; Fearon, E.M.; Mapoles, E.R.; Gaines, J.R.; Sater, J.D.; Fedders, P.A. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1118-1123(May 1986). Contract W-7405-ENG-48.

It appears that parallel alignment of deuteron and triton magnetic moments increases the cross section of the nuclear reaction T(d,n) He^4 by 50%, thereby promising a laser driver of perhaps half the original energy. Both "brute-force" and dynamic nuclear polarization are considered and the many potential problems of the latter are considered. High nuclear polarization by the dynamic technique requires a small nucleus-to-unpaired electron ratio, a long longitudinal nuclear relaxation time and a short longitudinal electron relaxation time. Normal D—T is shown to be inadequate, and enriched and possibly very pure molecular DT will be required. The key variable is the nuclear relaxation time, which can either depend on the interaction with rotationally excited impurity molecules or on paramagnetic defects formed by the tritium radiation. Radiation-induced DT decomposition and rotational catalysis will combat one another to affect the DT purity. The expected atom density and fractionation effects are considered. There exists one frequency at which both D and T atoms can be pumped.

39391 Tritium gettering from air with hydrogen uranyl phosphate. Souers, P.C.; Uribe, F.S.; Stevens, C.G.; Tsugawa, R.T. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1150-1154(May 1986). Contract W-7405-ENG-48.

Hydrogen uranyl phosphate (HUP), a solid proton electrolyte, getters tritium gas and water vapor from air by dc electrical action. We have reduced the formation of residual tritiated water to less than 2% and demonstrated that HUP can clean a 5.5 m^3 working glove box. Data are presented to illustrate the parameters of the gettering and a model is derived. Two other tritium gettering electrolytes have been discovered.

39392 Flashover lithium ion source development for large pulsed power accelerators. Bieg, K.W.; Burns, E.J.T.; Gerber, R.A.; Olsen, J.N.; Lamppa, K.P. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 772-776(May 1986). Contract AC04-76DP00789.

The Particle Beam Fusion Accelerator II (PBFA II), a light-ion pulsed power accelerator intended for inertial confinement fusion (ICF) applications, is currently under construction at Sandia National Laboratories. The accelerator will deliver a 30 MV, 5 MA lithium beam from an Applied-B diode to drive an ICF target. The ion source for this diode will require a thin (~1 mm), dense (10^{16} cm^{-3}) anode plasma layer of singly ionized lithium over an anode area of 10^3 cm^2. One type of source being investigated is the flashover ion source, which generates the anode plasma via vacuum flashover of a lithium-bearing dielectric material. Experiments with a LiF flashover source on the 0.03 TW Nereus accelerator have shown that contaminant ions account for as much as 70% of the extracted ion beam current. To overcome this, we have explored in-diode cleaning of the externally prepared anode surface by glow discharge cleaning and vacuum baking as well as in-diode preparation of the anode surface by vacuum evaporation of the lithium dielectric. Lithium-bearing dielectric materials which have been investigated include LiF, LiI, $LiNO_3$, and Li_3N. These techniques have resulted in a two to threefold improvement in the extracted lithium ion purity. As a result, a glow-discharge cleaned LiF flashover source will be used for initial pulsed-power testing on PBFA II.

39393 Microcellular foams via phase separation. Young, A.T. (Materials Science and Technology Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1128-1133(May 1986). Contract W-7405-ENG-36.

A study of wide variety of processes for making plastic foams shows that phase separation processes for polymers from solutions offer the most viable methods for obtaining rigid plastic foams which meet the physical requirements for fusion target designs. Four general phase separation methods have been shown to give polymer foams with densities less than 0.1 g/cm^3 and cell sizes of 30 μm or less. These methods involve the utilization of nonsol-

vent, chemical or thermal cooling processes to achieve a controlled phase separation. Two distinct phases are obtained where either the polymer phase is a continuous phase or two bicontinuous phases are obtained where both the polymer and solvent are interpenetrating, continuous, labyrinthine phases. Subsequent removal of the solvent gives the final foam structure.

39394 **Hollow droplet generator for polymer shell production.** Crawley, R. (KMS Fusion, Inc., Ann Arbor, Michigan 48106). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1138-1141(May 1986). Contract AC08-82DP40152.

Small, spherical, polymer shells are used as fuel containers in inertial fusion experiments. These shells have traditionally been made by spray drying or more recently using droplet generators. It has proven difficult to control product size and wall thickness for thermosetting materials. In this work we describe a dual orifice droplet generator for making hollow shell preforms. The inner orifice injects bubbles of a desired gas into the polymer solution droplet stream. The stream is agitated using a piezoelectric diaphragm and produces uniformly sized hollow droplets. Shells formed from these hollow preforms have tight distributions of diameter and wall thickness.

39395 **Ablation layer coating of mechanically nonsupported inertial fusion targets.** Gram, R.Q.; Kim, H.; Mason, J.F.; Wittman, M. (Laboratory for Laser Energetics, University of Rochester, Rochester, New York 14623-1299). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1145-1149(May 1986). Contract FC08-85DP40200.

Ablation layers are deposited on DT-filled glass microballoon targets by a parylene coating scheme while the targets are bounced on the surface of a mechanical resonator. Optimum bouncing is achieved with the resonator surface moving with a peak vertical velocity of ~3 cm/s at a frequency much greater than the bounce frequency of the targets. The resonator, a solid cylinder of high-Q material, uses a longitudinal mode of vibration to achieve vertical motion, which is uniform over its surface. A flexural mode of the cylinder is used for dislodging targets which have become stuck. In their natural state, the targets become charged triboelectrically and by the beta emission from the tritium decay. The adhesion of these charged targets is eliminated by creating a low power plasma in the bouncing region. Real time monitoring and control of coating thickness are achieved by use of a laser reflectometer. Coatings are examined with electron microscopy and x-ray radiography.

39396 **Influence of impurity and particle control on Tandem Mirror Experiment Upgrade plasma operation.** Allen, S.L.; Yu, T.L.; Foote, J.H.; Pickles, W.L. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1075-1078(May 1986). Contract W-7405-ENG-48.

A variety of techniques are used in Tandem Mirror Experiment-Upgrade (TMX-U)= to control impurities and reflux: repeated plasma pulses, glow discharge cleaning (GDC), and gettering. We performed a series of experiments under three different plasma-wall conditions: no wall conditioning after a machine maintenance cycle, glow-discharge-cleaned wall, and a gettered wall. We used several plasma diagnostics to determine the effect of these procedures on TMX-U plasma parameters. Spectroscopic measurements show that GDC reduces impurities and increases the electron temperature, enabling full-duration beam-sustained plasma operation without a large number of repeated plasma pulses. Gettering further reduces the impurities and the neutral pressure; this improved condition persists for several shots after gettering is stopped. Measurements from residual gas analyzers and an end-loss ion spectrometer show that hydrogen is present in the plasma during the initial deuterium operation after pumpdown; the hydrogen level decreases after plasma operation with gettering, indicating reduced wall recycling.

39397 **Surface analysis of 1984/1985 Tokamak Fusion Test Reactor limiter tiles.** Pontau, A.E.; Wampler, W.R.; Mills, B.E.; Doyle, B.L.; Wright, A.F.; Ulrickson, M.A.; LaMarche, P.H.; Dylla, H.F.; Fukuda, S. (Sandia National Laboratories, Livermore, California and Albuquerque, New Mexico 87185). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1193-1197(May 1986). Contract AC04-76DP00789;AC02-76CH03073.

Bare POCO AXF-5Q graphite tiles were installed as the plasma-facing surface of the Tokamak Fusion Test Reactor (TFTR) movable limiter for a series of ~ 2700 high power discharges (600 with up to 6 MW neutral beams). During this operating phase, erosion and deposition processes modified the surface of the limiter. In the regions of the most intense plasma contact, which reached temperatures over 2400°C, only small amounts of metallic impurities ($<5 \times 10^{16}$ atoms/cm^2) are observed during subsequent beta backscattering and proton-induced x-ray emission (PIXE) analysis. Also observed in these regions are several small areas of surface crazing, and scattered droplets of metals (~ 1 mm diam) presumed to originate from melted internal hardware. In regions more removed from direct plasma contact, thicker metallic deposits are observed (~ 2×10^{18} atoms/cm^2). There are more of these deposits on the side facing the electron drift direction than on the ion drift side. The metallic deposits are composed of ~ 55% Ni, 25% Cr, and 20% Fe and several trace elements. Near-surface retained deuterium levels vary from 10^{16} to 10^{18}/cm^2 along one ion-side/electron-side pair of tiles. Deuterium from TFTR operations in the bulk of a tile may have been as much as 5 ppm. Hydrogen in the tile was ~1 at. %. Surface roughness measured outside the intense plasma contact region is much more than the original POCO AXF-5Q graphite, whereas within the plasma contact region, tile surfaces are somewhat smoother than they were initially. Two of the tiles in high heat flux regions broke during operation. The resulting geometry change led to areas of enhanced erosion and nearby redeposition of carbon.

39398 **Hydrogen isotope exchange and conditioning in graphite limiters used in the Tokamak Fusion Test Reactor.** LaMarche, P.H.; Dylla, H.F.; McCarthy, P.J.; Ulrickson, M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1198-1202(May 1986). Contract AC02-76CH03073.

Isotopic exchange experiments performed in the Tokamak Fusion Test Reactor (TFTR) are used to examine the outgassing and diffusive properties of graphite used as the plasma limiter. Changeover from hydrogen to deuterium for different periods ranges from ~600 to 60 plasma discharges, which appears to be correlated in the limiter temperature. We present a simple analytical model that predicts a fast transient (~10 plasma discharges) changeover, where the deuterium fueling dilutes the adsorbed and near surface hydrogen, and a slowly changing term where bulk hydrogen diffuses to the surface. Using this model we can extract an activation energy for diffusion of 0.15 +- 0.02 eV. We hypothesize that interpore diffusion for this porous (~15%) material is consistent with our observations.

39399 **Migration of beryllium in the Impurity Study Experiment-B tokamak during the Beryllium Limiter Experiment.** Langley, R.A.; Zuhr, R.A.; Lewis, M.B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1203-1206(May 1986).

A beryllium limiter was installed in the Impurity Study Experiment-B (ISX-B) tokamak to test the applicability of beryllium as a plasma-side component for possible use in the Joint European Torus (JET). This test was a collaborative effort involving both ORNL and JET personnel. The ISX-B tokamak was operated for more than 3000 high power neutral beam injected discharges using the beryllium limiter as the main confining aperture. In order to access the migration of beryllium in the tokamak and attached diagnostics, both stainless steel and silicon samples were placed at various strategic positions and used as catcher plates. Nuclear reaction analysis was used to measure the beryllium deposited on the plates and provided a measure of the beryllium migration. Both particu-

lates and a thin film were found. The toroidal distribution of these two migration components is presented as well as a discussion of the analysis technique for the deposited beryllium. Analysis was made of the distribution of beryllium particulate matter deposited on the inside of the vessel wall. Both a size distribution and spatial distribution are presented.

39400 **Weight change measurements of erosion/deposition at beryllium limiter tiles in the Impurity Study Experiment-B.** Roberto, J.B.; Edmonds, P.H.; England, A.C.; Gabbard, A.; Zuhr, R.A. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1210-1212(May 1986). Contract AC05-84OR21400.

The weight changes of Be tiles which functioned as a rail limiter in ISX-B for more than 3500 beam-heated discharges have been determined. The net weight loss for the limiter was 2.0 g, with the central tiles losing a total of 3.2 g, and the inboard tiles gaining 1.2 g. The weight loss is attributed primarily to the release of Be droplets as a result of limiter surface melting. The weight gains resulted from an inward flow of molten material along the limiter surface. The results indicate high erosion (melt loss) with incomplete and nonuniform redeposition (melt flow) of limiter material during periods of limiter melting.

39401 **Calibration and characterization of Bayard—Alpert gauges operating in high magnetic fields.** Pickles, W.L.; Hunt, A.L. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1732-1735(May 1986). Contract W-7405-ENG-48.

Standard Bayard—Alpert gauges have been successfully operated for several months in 0.3—0.7 T magnetic fields at eleven locations near the plasma edge of the Tandem Mirror Experiment-Upgrade (TMX-U). After individual calibration in the local TMX-U magnetic field, the gauges clearly measure gas density. One of these eleven gauges has been studied extensively and has maintained calibration within 12% during this period of operation. All gauge filaments are tungsten and are heated with direct current. The gauge housing allows operation in the low density plasma outside the limiter radius by thermalizing the neutral gas that enters the gauge and by preventing plasma from entering the gauge. Changing the orientation of the gauge with respect to the magnetic field changes the gauge calibration, or effective sensitivity, by as much as a factor of 100. Only some orientations of the filament collector plane with respect to the magnetic field direction allow calibrated operation as a pressure gauge. This range of angles is approximately from 20° to 50°. Each of the eleven gauges was oriented to produce a usable sensitivity, then calibrated for the magnetic field effects at that position. After initial operation in the magnetic field, a small recalibration of less than 10% for permanent filament distortion was necessary for the unshielded gauge. For D_2, CH_4, X/ sub e/ and Kr gas, the measured recalibration factor to the gauge sensitivity in the same high magnetic field varied only 16% rms about the average of 9.7 for the unshielded gauge. Repeated measurement of the magnetic recalibration for each of the species over a 1 month period showed less than 12% variation.

39402 **Design, construction, and testing of the vacuum vessel for the tandem Mirror Fusion Test Facility.** Gerich, J.W. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1742-1748(May 1986). Contract W-7405-ENG-48.

In 1980, the U.S. Department of Energy gave the Lawrence Livermore National Laboratory approval to design and build a tandem Mirror Fusion Test Facility (MFTF-B) to support the goals of the National Mirror Program. We designed the MFTF-B vacuum vessel both to maintain the required ultrahigh vacuum environment and to structurally support the 42 superconducting magnets plus auxiliary internal and external equipment. During our design work, we made extensive use of both simple and complex computer models to arrive at a cost-effective final configuration. As part of this work, we conducted a unique dynamic analysis to study the interaction of the 32 000 tonne concrete-shielding vault with the 2850 tonne vacuum vessel system. To maintain a vacuum of 2×10^{-8} Torr during the physics experiments inside the vessel, we designed a vacuum pumping system of enormous capacity. The vacuum vessel (4200 m^3) has been fabricated, erected, and acceptance tests have been completed at the Livermore site. The rest of the machine has been assembled, and individual systems have been successfully checked. On October 1, 1985, we began a series of integrated engineering tests to verify the operation of all components as a complete system.

39403 **Chromium getter studies in the Tokamak Fusion Test Reactor.** Dylla, H.F.; LaMarche, P.H.; Blanchard, W.R.; Budny, R.V.; Boody, F.P.; Bush, C.E.; Groebner, R.J.; McCarthy, P.J.; Simpkins, J.E.; Stratton, B.C. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1753-1757(May 1986). Contract AC02-76CH03073.

We have studied the effects of the deposition of thin films (~0.1 μm) of chromium onto ~70% of the torus area of the Tokamak Fusion Test Reactor (TFTR). The purpose of these experiments was to test the difference between high surface coverage and high pumping speed gettering schemes with respect to minimizing oxygen impurity generation in high power tokamak discharges. The initial Cr deposition had significant effects on vessel outgassing and subsequent plasma performance: the outgassing of H_2O, CO, and CO_2 decreased by a factor of 10, oxygen impurity radiation decreased by a factor of 2, the plasma Z/sub eff/ decreased from 1.3 to 1.1, and the plasma density limit increased by 20%. This improvement correlates with a significant reduction of the edge radiation as the density limit is approached. The effects of the initial and subsequent Cr depositions were relatively long lasting, exhibiting time constants of the order of weeks. We attribute the observed impurity reduction to a modification of the oxide surface on the vessel wall which is apparently a significant impurity source for oxygen.

39404 **Surface thermography.** Ulrickson, M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Journal of Vacuum Science and Technology, A: Vacuum, Surfaces, and Films;* 4: No. 3, 1805-1809(May 1986). Contract AC02-76CH03073.

The temperature sensitivity of many plasma materials interactions in both fusion plasmas and process plasmas requires the determination of the surface temperature of the material in contact with the plasma. The determination of the surface temperature is made difficult by the presence of the plasma, the large electrical potentials that may be present, and the need to not contaminate the surface. Radiation thermography permits determination of the surface temperature while overcoming the difficulties listed above. This paper briefly discusses thermal radiation, Planck's Law, and the selection of the best wavelength band for a given temperature range. Both one and two color pyrometry are discussed. Several considerations that are necessary for practical applications are discussed. Some examples of the use of radiation thermometry in fusion applications between 350 and 3000 °C are presented. Surface heat flux has also been determined from the time variation of the surface temperature.

39405 **Thermal conductivities for sintered and sphere-pac Li_2O and γ-$LiAlO_2$ solid breeders with and without irradiation effects.** Liu, Y.; Tam, S.W. (Argonne National Lab., IL). *Fusion Technology;* 7: 399-410(May 1985).

Thermal conductivities (k,k/sub eff/) have been estimated for sintered and sphere-pac Li_2O and γ-$LiAlO_2$ with and without neutron irradiation effects. The estimation is based on (a) data from unirradiated UO_2, Li_2O, and γ-$LiAlO_2$; (b) data from irradiated dielectric insulator materials; and (c) relatively simple physical models. Comparison of model predictions with limited ex- and in-reactor data found reasonable agreement, thus lending credence for their use in design applications. The impact of thermal conductivities on tritium breeding and power generation in fusion solid breeder blankets is briefly highlighted. 30 references, 10 figures, 1 table.

39406 Prevention of impurity accumulation in classical tokamaks. Ohkawa, Tihiro. (GA Technologies, Inc., San Diego, CA, USA). *Kakuyugo Kenkyu;* **53**: No. 2, 161-168(Feb 1985).

A new method of impurity control in toroidal devices is proposed. Density inhomogeneity on flux surfaces produced by beam injection or RF heating creates a poloidal electric field. The resultant impurity ion distribution and orbit leads to the reversal of the impurity inflow.

39407 Magnetic flux surface mapping in the Proto-Cleo Stellarator. D'Haeseleer, W.D.; Anderson, D.T.; Anderson, F.S.B.; Doerner, R.P.; Mertens, K.J.; Shohet, J.L.; Treffert, J.D. (Torsatron/Stellarator Lab., Univ. of Wisconsin-Madison, Madison, WI). pp 2P-8 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC02-84ER53166.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The magnetic flux surface topology of the University of Wisconsin Proto-Cleo Stellarator has been reexamined experimentally in order to verify the presumed magnetic structure in the device. The experiment utilized an electron beam injected parallel to the 1.2 kG magnetic field. The beam was detected by a probe which could be scanned through the containment volume. The experimentally measured passes of the electron beam are subsequently compared with numerical data obtained from the drift surfaces traced out by a simulated beam. This is basically the same technique as used for a similar experiment performed on the Interchangeable Module Stellarator (IMS), a few months earlier. The authors have mapped four flux surfaces and obtain relatively good agreement between the experiment and the theoretical prediction. It is important to note that the magnetic structure depends sensitively on the current ratio in the toroidal and helical coils. Actual measurement of this current ratio showed that the existing ratio equals 1.48 instead of the previous ratio of 1.33. This latter ratio leads to a theoretical rotational transform at the edge of 0.6, while the authors found a lower iota value of about 0.5, being consistent with the larger current ratio.

39408 Proton ring trapping in a magnetic mirror. Pedrow, P.D.; Greenly, J.B.; Hammer, D.A.; Sudan, R.N. (Cornell Univ.). pp 2Q-4 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC02-77ET53005.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Proton rings trapped by a gated mirror have been studied in solenoidal fields of 6kG (300keV protons) and 8kG (430keV protons) with puffed and static hydrogen gas fills. The rings are formed by injecting a proton beam from an annular magnetically insulated diode (mean radius 10 cm) through a magnetic cusp to convert parallel velocity to rotational velocity. Primary diagnostics are Faraday cups, B-dot loops, shadow boxes, and damage targets. The trapped rings at 8 kG make eight passes through the length of the 1.5 meter mirror and have a lifetime of 4 μs. The measured bounce frequency (≈1MHz) is consistent with that predicted by a Hamiltonian description of single particle motion. The injected ring contains 2×10^{13} protons and after 8 bounces, the number has dropped to 2×10^{13} protons. Particle losses are believed to be caused by charge-exchange and mirror losses. Calculations show that many of the protons can be neutralized by a charge-exchange event and be lost as a neutral before the captured electron is stripped away. Mirror losses are caused by imperfect diode-cusp performance or by a change in proton pitch angles due to collisions, instabilities, and/or incomplete space-charge neutralization. Calculations show that the 4μs trapping lifetime is to due to the classical stopping power of the background hydrogen.

39409 Observation of diminished railgun performance -- possible causes and solutions. Hawke, R.S.; Nellis, W.J. (Lawrence Livermore National Lab., Livermore, CA). pp 5B-3 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract W-7405-ENG-48.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

The authors have fabricated and tested three precision round bore railguns. One was 1.6 m long and two were 5.2 m long. All were mated to a 1 m long, 35 mPa helium gas gun which injected 1 g projectiles at 1.2 km/s. The 1.6 m railgun used copper for rails and unidirectional fiberglass loaded Extrin (FLE) for rail spacers and supports. This railgun operated as expected and successfully launched 1 g and 4 g projectiles at 4.2 and 3.0 km/s, respectively. The first 5.2 m long railgun was also made from copper rails and FLE spacers. Erosion of this spacer was substantial and the maximum velocity achieved was 5 km/s. A second 5 m gun was made with copper rails and polycarbonate spacers--the latter chosen for its greater erosion resistance. Maximum velocity was increased to 6.6 km/s, however, more than 12 km/s was expected. Generally, the performance of the 5 m railguns was expected for ≈2 m of acceleration to ≈4 km/s and is consistent with the performance of the 1.6 m prototype. Achievement of less than expected performance in the 5 m railguns could be the result of (1) excessive mass accretion in the arc, (2) parasitic conduction in the insulator, (3) secondary arc restrike, (4) arc/launcher viscous drag, (5) large dm/dt term in the force balance, and/or (6) reduced L' due to an expanded arc.

39410 A target plane imager for inertial confinement fusion. Swift, C.D.; Bliss, E.S.; Jones, W.A.; Seppala, L.G. (Inertial Confinement Fusion Program, Lawrence Livermore National Lab., Livermore, CA 94550). pp 261-263 of Southwest conference on optics. SPIE volume 540. Bellingham, WA; SPIE - The International Society for Optical Engineering (1985). (CONF-8503156—). Contract W-7405-ENG-48.

From Society of Photo-Optical Instrumentation Engineers conference; Albuquerque, NM, USA (6 Mar 1985).

The Nova laser, completed in December 1984 at Lawrence Livermore National Laboratory, is being used to conduct inertial confinement fusion experiments. It is capable of focusing more that 100 kJ of energy on small fusion targets. This paper discusses an optical system called the target plane imager (TPI) that is used during the beam alignment phase of these experiments. The TPI includes a three meter long periscope with a wide field of view, f/3 objective. The telescope relays images of the target focal plane to viewing optics and a video sensor located outside the target chamber. Operation of the system is possible at three wavelengths" 1.05μ, 0.527μ, 0.351μ. These are the three wavelengths at which the ten NOVA laser beams can irradiate targets. Both nearfield and farfield images of the ten beams can be viewed with the TPI. This instrument is used to properly align the laser to the target before each target irradiation.

39411 Reduced variation in the neutron output of the dense plasma focus. Hill, R.A. (Sandia National Labs., Albuquerque, NM). pp 5A-1 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract AC04-76DP00789.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

As previously discussed, a series of modified cathodes is being tested in our ultra-high vacuum dense plasma focus (DPF) device. Constructed entirely from high-vacuum components using metal-to-metal and ceramic (Al_2O_3)-to-metal seals, the entire DPF assembly is given a vacuum bake at 250°C resulting in a pre-fill vacuum of 5×10^{-9} torr. Powered by a 7-μf capacitor bank operated at 20 kV, a sustained neutron output of ≈$(1.02\ 0.38) \times 10^{9}$ was obtained for over 300 shots on one gas filling. In an effort to reduce the amount of contaminant gases, and in particular, the amount of oxygen in the DPF tube, a molybdenum cup was installed coaxial with and surrounding the cathode to act as a barrier

to prevent contact of hot plasma and the high-energy ion beam with the stainless steel vacuum walls. Also, all components of the fill system, pump-out system, and vacuum system (304 stainless steel) were passivated with a wet hydrogen firing at 700°C in order to inactivate the interior surfaces.

39412 **The TFTR Lithium Blanket Module Program - A status report.** File, J.; Jassby, D.L.; Bertone, P.C.; Engholm, B.A.; Hayer, E.R.; Lindgren, J.; Yang, L.; Tsang, F.Y.; Harker, Y.D.; Anderl, R.A. (GA Technologies Inc., San Diego, CA). pp 1399 of Fusion technology 1984. Volume 2. Elmsford, NY; Pergamon Press (1985). (CONF-840915—). Contract AC02-76CH03073.

From 13. symposium on fusion technology; Varese, Italy (24 Sep 1984).

The Lithium Blanket Module (LBM) is an approximately cubic blanket module that will be installed on the Tokamak Fusion Test Reactor (TFTR) in late 1986. Measurements of neutron transport and tritium breeding will be made with the TFTR D-D and D-T fusion neutron source. This report describes the final design and fabrication of the LBM, and the status of preparation for the experimental program.

39413 **Simulations of Tokamak sputtering conditions with high energy particle beams.** Youchison, D.L.; Nahemow, M.D.; McGrath, R.T. (Pennsylvania State Univ., University Park, PA). pp 4R-6 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—).

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

Physical sputtering of first wall and impurity control surfaces results in a substantial impurity source to a tokamak plasma. Unfortunately, only a limited sputtering yield data base exists for currently proposed impurity control surface materials. The variation of sputtering yields caused by hydrogen isotope and helium contamination due to ion implantation and adsorption is virtually unknown. This lack of fundamental data has hindered present efforts to model particle transport in the plasma edge region. This situation exists because plasma edge conditions and plasma-surface interactions are intimately coupled. Sputtering yield data for contaminated and redeposited surfaces can provide valuable information for improved edge modeling and impurity control design. In order to expand the sputtering yield data base for fusion impurity control materials a refined ion-surface interaction system has been developed at the Westinghouse Research and Development Center. This facility has the capabilities necessary to condition impurity control test samples to simulate some prior exposure to tokamak plasmas. This is achieved through ion implantation and subsequent sputtering using a 30keV ion beam complete with deceleration optics. A quartz crystal oscillator microbalance functions as the transducer. The in situ conditioning capabilities of the system will be discussed alone with data obtained for a preliminary series of sputtering experiments.

39414 **Omega: A 24-beam UV irradiation facility.** Richardson, M.C.; Beich, W.; Delettrez, J.; Dunn, M.; Folnsbee, L.; Hutchison, R.J.; Jacobs, S.A.; Keck, R.L.; Kessler, T.; Lampeter, W. (Univ. of Rochester, Lab. for Laser Energetics, Rochester). pp 234 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The authors report on the characterization and performance of the 24-beam Omega laser facility under full third harmonic (351-nm) upconversion. This system provides for the first time a multi-beam laser facility for the illumination of spherical targets with UV laser light in symmetric irradiation conditions with energies in the kilojoule range. This facility is capable of providing sufficient irradiation uniformity to test concepts of direct drive laser fusion with UV-driven ablation targets. The results of initial studies of ablatively driven DT-fueled glass microballoon targets will be described. The 24-beam Omega Nd:phosphate glass facility is capable of providing at 1054 nm output powers in excess of 10 TW in short (<100-psec) pulses and maximum energies of $\approx$4 kJ in nanosecond duration pulses. Focused with f/3 lenses in a small regular rhombicuboctahedral array, it provides a reliable ($>10^4$ full system shots to date) irradiation facility with beam synchronism of $\approx$3 psec, beam placement accuracy on target of 10 μm, and interbeam energy variance of $\approx$2%. From measured target plane intensity distributions, overall illumination uniformity with tangentially focused beams is estimated to be $\approx$5%. In 1984, a symmetric set of six beams was upconverted to 351-nm radiation using the polarization-mismatch scheme developed by Craxton. Monolithic cells of 20-cm clear aperture containing both frequency and doubler and tripler type II KDP crystals in index-matching propylene carbonate liquid were incorporated to output of six of the Omega beams with a full set of UV beam diagnostics.

39415 **Design and performance of the Nova frequency conversion system.** Summers, M.A.; Williams, J.D.; Johnson, B.C.; Eimerl, D. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 256 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The Nova laser is equipped with ten large-aperture (74-cm) potassium dihydrogen phosphate (KDP) crystal arrays capable of converting the fundamental wavelength (1.054 μm) to the visible (0.527-μm) or ultraviolet (0.351-μm) light. Each array assembly consists of a 3 x 3 deep-web aluminum eggcrate, which supports two crystal arrays configured in the quadrature 2ω/cascade 3ω architecture. The individual crystals are precisely machined so that the phase-matched direction is accurately located with respect to the crystal surface normal (+-30 μrad). The eggcrate supports each crystal so that the surface normals are parallel to within +-30 μrad. The completed assembly is angle tuned for peak conversion efficiency to +-30 μrad relative to the input beam. The Nova crystal arrays are installed just before the target focus lens where the beams are linearly polarized, collimated (+-50 μrad), and 74 cm in diameter. Angle tuning is facilitated by a precision two-axis gimbal which can also rotate the array about the beam direction. Each of the ten gimbals is controlled from a local control console or the main control room. Infrared operation is achieved by detuning the array so that no conversion takes place. Operation at 0.527 μ is achieved by angle tuning the assembly so that both crystals convert the fundamental to the second harmonic. The assembly is rotated about the beam axis to achieve the correct input polarization. Operation at 0.351 μm is achieved by tipping the assembly $\approx$5 mrad and rotating $\approx 10^6$ so as to tune the second crystal for mixing. The Nova frequency conversion subsystem has recently been activated, and preliminary measurements made on the optical quality and overall conversion efficiency are reported.

39416 **Transport of laser generated hot electrons through vacuum and low density foam.** Heidrich, J.E.; Lear, R.D.; Slivinsky, V.W.; Ault, S.K.; Landen, O.L.; Kilkenny, J.D. (Lawrence Livermore National Lab., Livermore, CA). pp 3B10 of IEEE conference record-abstracts of the 1985 IEEE international conference on plasma science. Piscataway, NJ; IEEE Service Center (1985). (CONF-850699—). Contract W-7405-ENG-48.

From Conference on plasma sciences; Pittsburgh, PA, USA (3 Jun 1985).

A 1.06-μm laser focused to a 30-μm diameter was used to irradiate vacuum gap and 0.03g/cc foam targets with 80 to 130-J, 1-ns and 25 to 50-J, 250-ps pulses, respectively. The vacuum gap targets, fabricated with 11-μm polystyrene followed by 20 to 250-μm vacuum gaps followed by 13-μm Cu, were used to study gap-closure and space-charge-limit phenomena. While the low density foam targets, fabricated with layers of 1-μm parylene, 1-μm Fe, 50 to 400-μm foam and 13-μm Cu, were used to study electron transport and spreading. For both types of targets, the transported electrons incident upon the Cu foil produced Cu Kα x-rays that were used to indicate the number of transported electrons. For the foam targets, hot electrons incident upon the Fe foil produced Fe Kα x-rays, which indicate the initial electron production. An array of seven PIN detectors filtered respectively by Sc, Cr, Fe, Co, Ni, Se,

and Sn foils were used to measure the x-ray spectrum. The spatial distribution of transported electrons was obtained for both types of targets by comparing x-ray images obtained from two pinhole cameras; one used an Ni filter, which transmitted the Cu Kα x-rays produced by the hot electrons, and the other used a Co filter, which did not transmit the Cu Kα x-rays. For the foam targets, the camera using the Co filter produced an image of the Fe Kα x-rays and, thus, was used to determine the size of the hot electron spot produced in the initial parylene layer.

39417 Remote maintenance of TFTR components. Holloway, C.; Burgess, D.; Stringer, J.; Szirtes, T.; King, M. (Remote Handling Group, Princeton Plasma Physics Lab., Princeton, NJ). pp 1312 of Fusion technology 1984. Volume 2. Elmsford, NY; Pergamon Press (1985). (CONF-840915—). Contract AC02-76CH03073.

From 13. symposium on fusion technology; Varese, Italy (24 Sep 1984).

To support the TFTR experimental program leading to energy breakeven and beyond, a development program has been initiated to provide for the remote maintenance of selected reactor components. These components have been identified according to their probability of failure and the criticality to the success of the experimental mission. This paper describes the development of hardware and the presentation of mock-up demonstrations during the initial phase of the remote handling plan.

39418 Thermomechanical testing of beryllium for the JET/ISX-B beryllium limiter experiment. Watson, R.D.; Smith, M.F.; Whitley, J.B.; McDonald, J.M. (Sandia National Laboratories, Albuquerque, NM). pp 1283-1290 of Fusion technology 1984. Volume 2. Elmsford, NY; Pergamon Press (1985). (CONF-840915—). Contract AC04-76DP00789.

From 13. symposium on fusion technology; Varese, Italy (24 Sep 1984).

Materials testing of S-65-B beryllium has been conducted in support of the beryllium limiter experiment on the ISX-B tokamak at Oak Ridge National Laboratory. The S-65-B grade of hot-pressed beryllium was chosen over S-200-E because of its superior strength and ductility at elevated temperatures. The testing has included measurement of tensile and yield strength, ductility, Young's Modulus, thermal conductivity, and specific heat from 50°C to 700°C. Thermal fatigue testing of a 2.5 cm beryllium cube was conducted using an electron beam to apply a heat flux of 2.5 kw/cm^2 for 0.3 second pulses for 1500 cycles. Results from the tests are compared to elastic-plastic finite element stress calculations. The testing indicates that the ISX-B beryllium limiter should survive the tokamak environment without serious structural failure, although some surface cracking is expected to occur.

39419 Design and fabrication of a beryllium limiter for ISX-B. Edmonds, P.H.; Watson, R.D.; Smith, M.F. (Oak Ridge National Lab., Oak Ridge, TN). pp 1275-1282 of Fusion technology 1984. Volume 2. Elmsford, NY; Pergamon Press (1985). (CONF-840915—). Contract AC05-84OR21400;AC04-76DP00789.

From 13. symposium on fusion technology; Varese, Italy (24 Sep 1984).

A movable, temperature-controlled, beryllium rail limiter has been used in the Impurity Study Experiment (ISX-B) tokamak at the Oak Ridge National Laboratory (ORNL). The purpose of the experiment was to evaluate the suitability of the material for installation on the Joint European Torus (JET) experiment. The limiter was designed for a surface temperature rise of 600°C for each tokamak shot. This rise corresponds to a heat flux to the limiter surface of approximately 2.1 to 2.4 kW/cm^2 for 0.3 s. The experimental test was expected to require a lifetime of approximately 3000 neutral beam-heated plasma discharges to meet the planned surface fluence of 10^{25} hydrogen ions per cm^2. A temperature control system was used to maintain the base-plate temperature of the limiter at about 200°C. Normal plasma radius was 24 cm. The experimental results indicate that the beryllium limiter functions normally unless brought to melting point, when evaporated beryllium covers the liner walls, gettering the discharge. Under these conditions beryllium was the dominant impurity.

39420 Development of radiation-resistant organic insulators for magnetic fusion energy applications. Kasen, M.B. (National Bureau of Standards, Boulder, CO). pp 265-268 of Proceedings of the international conference on nuclear power plant aging, availability factor and reliability analysis. Goel, V.S. Metals Park, OH; American Society of Metals (1985). (CONF-850713—).

From International conference on nuclear power plant aging, availability factor and reliability analysis; San Diego, CA, USA (7 Jul 1985).

Current knowledge of cryogenic irradiation effects on organic-matrix electrical insulators required for the superconducting magnets in magnetically-confined, fusion energy systems is reviewed. It is concluded that the performance of presently available materials is marginal for such applications. Since the cost of substituting organic materials as insulators appears to be inordinately expensive, a program to develop organic insulators having improved performance is under way. This program will make use of the National Low Temperature Neutron Irradiation Facility currently being constructed at ORNL. The main features of the program are described.

39421 Aurora: A short-pulse multikilojoule KrF inertial fusion laser system. Rosocha, L.A. (Los Alamos National Lab., P.O. Box 1663, Los Alamos, NM). pp 186 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

Aurora is a laser system that serves as an operating technology demonstration prototype for large-scale high-energy KrF laser systems of interest for inertial fusion applications. This system will incorporate the following elements to achieve an end-to-end 248-nm laser fusion concept demonstration: an injection-locked oscillator-amplifier front end; an optical angular multiplexer to produce 96 encoded optical channels each of 5-nsec duration; a chain of four electron-beam-driven KrF laser amplifiers; automated alignment systems for beam alignment; a decoder to provide for pulse compression of some fraction of the total beam train to be delivered to target, and a target chamber to house and diagnose fusion targets. The front end configuration uses a stable resonator master oscillator to drive an injection-locked unstable resonator slave oscillator. An extension of existing technology has been used to develop an electrooptic switchout at 248 nm that produces a 5-nsec pulse from the longer slave oscillator pulse. This short pulse is amplified by a postamplifier. Using these discharge lasers, the front end then delivers at least 250 mJ of KrF laser light output to the optical encoder.

39422 Performance of the large aperture module of the Aurora krypton fluoride laser system. York, G.W.; Czuchlewski, S.J.; Rosocha, L.A.; Salesky, E.T. (Los Alamos National Lab., P.O. Box 1663, Los Alamos, NM). pp 188 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The large aperture module (LAM) is the final amplifier of the Los Alamos Aurora krypton fluoride (KrF) laser system. An artist's conception of the device is shown. It consists of a laser chamber with a 1-X1-m aperture and a 2-m active length which is directly pumped by opposing 1-X2-m electron beams (up to 675 kV at 20A/cm^2). Each electron gun is driven by two 2.7-Ω water pulse forming lines (PFLs) connected in parallel. The PFLs are each 10.7m long giving a 650-nsec pump pulse. Each pair of water lines is pulse charged by a Marx generator capable of producing up to 1.8 MV. A pair of Helmholz coils is provided to prevent beam pinching in the diodes and to ensure uniform pumping in the laser gas volume. The laser chamber can be filled with up to 1.5 atm of an Ar/Kr/F_2 lasing mixture.

39423 High-power target plane characterization diagnostics for the Nova laser. Ozarski, R.G.; Bender, D.A.; Gim, B.M.; Seppala, L.G. (Lawrence Livermore National Lab., P.O. Box 5508, Livermore, CA). pp 194 of Digest of technical papers from the OSA/IEEE 1985 conference on lasers and electro-optics. Washington, DC; Optical Society of America (1985). (CONF-850558—).

From Conference on lasers and electro-optics; Baltimore, MD, USA (21 May 1985).

The intensity distribution on a fusion target is an important quantity in understanding the performance of ICF targets. The extremely high intensity at the focus of the Nova laser and the geometry of the ten frequency-converted Nova laser beams have required a new approach to recording the far-field spatial and temporal intensity distribution. A diagnostic package to characterize the focal plane on Nova, know as the opposed part diagnostic (OPD), was developed for Nova. The OPD uses an inverse Cassegrain design to image the target plane of Nova from a port opposite the irradiating beam to be characterized. The OPD consists of two sections: a telescope module and a camera module. The telescope section is an inverse Cassegrain reflector design which is inserted into the target chamber. Because of space constraints, the telescope module folds into itself for insertion and then unfolds into the chamber. It primarily is a 74-cm aperture reflector. The energy density of the frequency-converted Nova beam at 0.53 and 0.35μm is too high for dielectric coatings. Therefore, the 4% Fresnel reflection of the uncoated primary is used, and the remainder of the beam energy is absorbed behind the primary. Use of the Fresnel reflection also avoids the distortion which would be induced in a refractive system due to the intensity dependent index of refraction (B integral). The secondary is also a Fresnel reflector which lowers the intensity sufficiently so that refracting optics can be used to collimate the beam and pass it through a vacuum window to the camera module outside the target chamber.

39424 Experimental lithium system experience. Atwood, J.M.; Berg, J.D.; Kolowith, R.; Miller, W.C. (Westinghouse Hanford Co., Richland, WA, USA). pp 641-346 of Liquid metal engineering and technology. 3 Vols. Proceedings of the 3. international conference held in Oxford on 9-13 April 1984. Vol. 2. London, England; British Nuclear Energy Society (1984). (CONF-840411—).

From 3. meeting on liquid metal in energy applications; Oxford, UK (9 Apr 1984).

The Experimental Lithium System is a test loop built to support design and operation of the Fusion Materials Irradiation Test Facility. ELS has achieved over 15,000 hours of safe and reliable operation. An extensive test program has demonstrated satisfactory performance of the system components, including an electromagnetic pump, lithium jet target, and vacuum system. Data on materials corrosion and behavior of lithium impurities are also presented.

39425 Testing of the prototype FMIT target with liquid lithium. Miller, W.C.; Annese, C.E.; Berg, J.D.; Miles, R.R. (Westinghouse Hanford Co., Richland, WA, USA). pp 333-340 of Liquid metal engineering and technology. 3 Vols. Proceedings of the 3. international conference held in Oxford on 9-13 April 1984. Vol. 2. London, England; British Nuclear Energy Society (1984). (CONF-840411—).

From 3. meeting on liquid metal in energy applications; Oxford, UK (9 Apr 1984).

Testing of a molten lithium target was performed to evaluate hydraulic stability, determine surface evaporation rates, and map the detailed contour of the high speed, free surface wall jet. The results confirmed predictions by demonstrating acceptable performance of a prototype target.

39426 Design of liquid lithium pumps for FMIT. Adkins, H.E.; Thorne, W.L.; Atwood, J.M. (Westinghouse Hanford Co., Richland, WA, USA). pp 347-352 of Liquid metal engineering and technology. 3 Vols. Proceedings of the 3. international conference held in Oxford on 9-13 April 1984. Vol. 2. London, England; British Nuclear Energy Society (1984). (CONF-840411—).

From 3. meeting on liquid metal in energy applications; Oxford, UK (9 Apr 1984).

In the Fusion Materials Irradiation Test (FMIT) facility, a jet of liquid lithium is bombarded by 35 meV deuterons to generate high energy neutrons for materials testing. The FMIT lithium system will include two electromagnetic (EM) pumps, a 750 gpm main pump and a 10 gpm auxiliary pump. The larger pump was designed and built in 1982, following extensive testing of a similar pump in the Experimental Lithium System (ELS). Design of the auxiliary pump has been completed, but fabrication has not started. This paper discusses the design considerations leading to selection of the Annular Linear Induction Pump (ALIP) concept for these applications. Design parameters, fabrication procedures, and results of pump testing are also reviewed.

39427 Application of lead and lithium-lead in fusion reactor blankets. Gordon, J.D.; Garner, J.K.; Hoffman, N.J. (TRW Energy Development Group, Redondo Beach, CA, USA; Rockwell International Corp., Canoga Park, CA, USA. Energy Technology Engineering Center). pp 329-336 of Liquid metal engineering and technology. 3 Vols. Proceedings of the 3. international conference held in Oxford on 9-13 April 1984. Vol. 1. London, England; British Nuclear Energy Society (1984). (CONF-840411—).

From 3. meeting on liquid metal in energy applications; Oxford, UK (9 Apr 1984).

Applications of lead and the eutectic of lead and lithium, 83Pb-17Li, in fusion blankets are discussed. Critical design issues associated with each heavy liquid metal are presented and conceptual designs that mitigate these problems are shown.

39428 Susceptibility of 2.25 Cr-1 Mo steel to liquid metal embrittlement by lithium-lead solutions. Eberhard, B.A.; Mullinaux, B.A.; Edwards, G.R. (Colorado School of Mines, Golden, USA). pp 337-345 of Liquid metal engineering and technology. 3 Vols. Proceedings of the 3. international conference held in Oxford on 9-13 April 1984. Vol. 1. London, England; British Nuclear Energy Society (1984). (CONF-840411—).

From 3. meeting on liquid metal in energy applications; Oxford, UK (9 Apr 1984).

Liquid metal induced embrittlement is characterized and shown to occur in 2 1/4Cr-1Mo steel wetted by lead, lithium, or a 99 atomic percent lithium - 1 atomic percent lead liquid. The severity of embrittlement in this liquid/solid metal couple is shown to be quite dependent on microstructure as determined by heat treatment. LMIE susceptibility is best reduced by heat treatments using low tempering temperatures and long tempering times.

99 GENERAL AND MISCELLANEOUS

39429 (DOE/MA—0229) Cost and schedule control systems criteria for contract performance measurement. Systems review/surveillance guide. (USDOE Assistant Secretary for Management and Administration, Washington, DC. Office of Project and Facilities Management). Jun 1986. 130p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86012460.

When the Department of Energy (DOE) Cost and Schedule Control Systems Criteria (CSCSC) are applied to a contract in accordance with DOE 2250.1B, the contractor's management control systems are reviewed by DOE to determine their initial and continuing compliance with the CSCSC. This document provides guidance to DOE personnel responsible for applying the CSCSC requirements on contracts, reviewing contractor implementation of the requirements, and surveillance to assure continuing compliance with the CSCSC.

39430 (DOE/RL/01830—H2) Department of Energy least-cost utility planning research agenda. (Temple, Barker and Sloane, Inc., Lexington, MA (USA)). 22 May 1986. Contract AC06-76RL01830. 36p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012638.

The US Department of Energy (DOE) Office of Conservation and Renewable Energy recently received an appropriation of nearly $1,000,000 to promote "least-cost planning" within the nation's electric and natural gas utilities. In accordance with the

provisions of that appropriation, the Office of Conservation and Renewable Energy has undertaken the development of a research plan to detail the most efficient and effective uses of the budget. Temple, Barker and Sloane (TBS) was retained as a subcontractor to Pacific Northwest Labs to assist in the development of this plan. This report describes TBS's findings from an extensive series of interviews on least-cost planning and recommendations for DOE's role in promoting the concept.

39431 **(SAND—86-1485C) Scientific and technical terminology in US translations.** Newman, P. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 7p. (CONF-860881—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012285.

From Asia Pacific regional conference on translation; Kuala Lumpur, Malaysia (17 Aug 1986).

Recommendations for terminology research in a country like the US include: use a bilingual dictionary with caution; translate only in familiar fields; literature published in the target language is the best source of new terminology; use secondary sources such as indexes and abstracts; establish personal contacts; record the answer; and share your knowledge. (DLC)

9901 Management

REFER ALSO TO CITATION(S) 38108, 38761

39432 **(AD-A—165865/7/XAB) Factors limiting endurance of armor, artillery, and infantry units under simulated NBC conditions.** Rauch, T.M.; Tharion, W.J.; Banderet, L.E.; Lussier, A.R. (Army Research Inst. of Environmental Medicine, Natick, MA (USA)). 13 Mar 1986. 15p. (USARIEM-M—18/86). NTIS, PC A02/MF A01.

The war of the future will require 72-hour operations in environments contaminated with nuclear/biological/chemical (NBC) agents. The 1985 P2NBC2 (Physiological and Psychological Effects of NBC and Extended Operations on Combined Arms Crews) Program assessed soldier endurance and performance under simulated NBC conditions. A total of 175 soldiers were observed during four tests differing in design, site, climatic conditions, and performance demands. In all but one of the iterations where the full chemical-protective ensemble (MOPP 4) was used without cooling, soldier endurance fell far short of the projected requirement. Psychological data were analyzed to determine which factors were associated with the incidence of casualties. The findings showed that perceived intensity of symptoms resembling the hyperventilation syndrome was significantly greater in soldiers classified as Casualties. Five of these symptoms (painful breathing, difficulty breathing, shortness of breath, headache, and nausea) showed Casualty-Survivor differences in all tests. Symptom intensity was attributed to two factors. (1) External conditions. Thermal stress exacerbated the five basic symptoms, induced others (tetany and paresthesia), and decreased endurance. Periodic relief from respirator use attenuated these symptoms and enhanced endurance. (2) Individual differences. Significant Casualty-Survivor differences in anxiety, depression, and cognitive strategy scores indicated that perception of hyperventilation symptoms and endurance were related to personality variables. Hyperventilation symptoms could incapacitate the soldier or induce removal of the protective mask under actual chemical attack.

39433 **(AD-A—166115/6/XAB) West European and East Asian perspectives on defense, deterrence, and strategy. Volume 6. South Korean perspectives on defense, deterrence, and strategy. Technical report, 1 December 1981-30 November 1982.** Pfaltzgraff, R.L.; Dougherty, J.E.; Davis, J.K.; Perry, C.M. (Institute for Foreign Policy Analysis, Inc., Cambridge, MA (USA)). 11 Apr 1984. 156p. NTIS, PC A08/MF A01.

This study addresses the international security perspectives of the Republic of Korea (South Korea). Particular emphasis is placed on the way in which American, Soviet, Chinese and Japanese interests intersect on the Korean Peninsula and on their impact upon the military balance between North and South Korea. A major portion of this analysis is devoted as well to an examination of inter-Korean relations, spotlighting the varying security implications of the continued partition, as opposed to the eventual reunification of the two Koreas. The importance to South Korea of the Seoul-Washington-Tokyo relationship is discussed, as well as the effect of the Sino-Soviet dispute on South Korean defense and foreign policies. In order to clarify further the strategic perspectives of key decision makers in Seoul, the study reviewed and assessed South Korean views on such controversial issues as the expansion of Japan's self-defense forces, the withdrawal of the U.S. ground troops from the Korean peninsula, Sino-Soviet moves toward rapprochement, and the proliferation of nuclear weapons in Northeast Asia.

39434 **(AD-A—166162/8/XAB) West European and East Asian perspectives on defense, deterrence, and strategy. Volume 1. Main report. Technical report, 1 December 1982-15 May 1984.** Pfaltzgraff, R.L.; Davis, J.K.; Dougherty, J.E.; Perry, C.M. (Institute for Foreign Policy Analysis, Inc., Cambridge, MA (USA)). 16 May 1984. 87p. NTIS, PC A05/MF A01.

This report provides a summary, analysis and categorization of the perspectives of defense elites in Western Europe, together with an examination of such perspective in the People's Republic of China, with special emphasis on nuclear capabilities and directly related security issues. In Europe, attention is focused on Great Britain, France, the Federal Republic of Germany, Belgium, The Netherlands, Portugal, and Spain. As a distinctive feature of this report, four schools of strategic thought have been developed for each of the European countries under study. Based upon a comprehensive assessment of the defense views held by strategic theoreticians, prominent government policymakers, political party leaders, and others active in the defense debates of Western Europe, these schools of thought provide a unique tool for identifying and evaluating key issues and spokesmen in the West European security debate of the 1980s. The overall objective of this study is to identify and assess the continuities and discontinuities of security perspectives among West European countries (especially concerning NATO's nuclear weapons options) and, on the basis of this analysis, to examine the prospects for maintaining, or strengthening, the consensus upon which European security is based. In its assessment of Chinese security perspectives, this report focuses on the evaluation of the PRC's strategic approach to international affairs and on the effects of recent personnel and organizational changes in the Chinese hierarchy on the PRC's foreign and defense policies.

39435 **(AD-A—166312/9/XAB) US national security policy. Revision. Final report.** (National Security Research, Fairfax, VA (USA)). Mar 1986. 253p. NTIS, PC A12/MF A01.

This essay is intended to survey the basic framework within which the United States will make national security decisions in the year 2010, focusing especially on American orientation toward the Atlantic (Europe) or the Pacific (Asia). Such a task for projecting the international environment some 30 years into the future is an intrinsically speculative intellectual exercise. The idea of this essay is that the existing international environment will more likely than not continue to be the pattern in 2010 – primarily because of the constraints established by the existence of nuclear weapons and the probable continuance of the U.S.-Soviet rivalry as the central factor in world politics. This suggests that the relative importance the United States has given to the Atlantic/Europe and the Pacific/Asia since 1945 will not shift dramatically. Section III then examines circumstances that might bring about a significant change or revolution in world politics by 2010, and the impact that this situation might have on the Atlantic-Pacific equation. This situation has two important implications for the US Navy and the associated U.S. power-projection forces. First, in terms of their contribution to the central U.S. alliance system, they should develop the follow-through for the defeat of the Red Fleet that will remain their overriding objective. Second, in terms of its contribution to the peripheral U.S. alliance system, the USN should refine its ability to fight and win limited conflicts.

39436 (LA-UR—86-2034) Three-level approach to quality programs for research, development and production. Davis, A.H.; Bussolini, P.L.; Geoffrion, R.R. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 6p. (CONF-860654—24). NTIS, PC A02/MF A01; GPO Dep. File Number DE86012370.

From 27. annual meeting of the Institute of Nuclear Materials Management; New Orleans, LA, USA (22 Jun 1986).

A primary mission of the Los Alamos National Laboratory is to develop nuclear weapons systems for the Department of Defense. The activities included in this effort cover a broad spectrum, ranging from pure research to routine production. In order to provide a workable framework for a comprehensive quality assurance program for these varied activities, we have proposed a three-level structure of quality plans, corresponding to a rough classification of the weapons work into three general categories. These categories are: (1) research into materials and processes, and preliminary development; (2) design, development, and fabrication of prototype components; (3) routine production, analysis, or refinement activities. The first category requires a quality program to assure the validity, reliability, and retrievability of the information developed; this is accomplished by a conscientious application of what is generally recognized as good laboratory practice. The second category requires in addition a strong emphasis on design review and inspection. For the third category, a comprehensive quality program is appropriate.

9902 Mathematics And Computers

REFER ALSO TO CITATION(S) 37490, 39302

39437 (AD-A—165693/3/XAB) Expert systems for C3I. Volume 1. A user's introduction. Final report. Clapp, J.A.; Hockett, S.M.; Prelle, M.J.; Tallant, A.M.; Triant, D.D. (Mitre Corp., Bedford, MA (USA)). Oct 1985. 60p. NTIS, PC A04/MF A01.

There has been a tremendous burgeoning of interest in artificial intelligence (AI) over the last few years. Investments of commercial and government sponsors reflect a widespread belief that AI is now ready for practical applications. The area of AI currently receiving the greatest attention and investment is expert system technology. Most major high tech corporations have begun to develop expert-systems, and many software houses specializing in expert system tools and applications have recently appeared. The defense community is one of the heaviest investors in expert-system technology, and within this community one of the application areas receiving greatest attention is C3I. Many ESD programs are now beginning to ask whether expert-system applications for C3I are ready for incorporation into ESD-developed systems, and, if so, what are the potential benefits and risks of doing so. This report was prepared to help ESD and MITRE personnel working on acquisition programs to address these issues and to gain a better understanding of what expert systems are all about. The primary intention of this report is to investigate what expert-systems are and the advances that are being made in expert system technology for C3I applications. The report begins with a brief tutorial on expert systems, emphasizing how they differ from conventional software systems and what they are best at doing.

39438 (AD-A—166058/8/XAB) Using multiple inverted trees for parallel updating of graph properties. Technical report. Ramakrishnan, I.V. (Maryland Univ., College Park (USA). Dept. of Computer Science). May 1985. 28p. (CAR-TR—124). NTIS, PC A03/MF A01.

Fast parallel algorithms are presented for updating the distance matrix, shortest paths for all pairs and biconnected components for an undirected graph and the topological ordering of vertices of a directed acyclic graph when an incremental change has been made to the graph. The kinds of changes that are considered here include insertion of a vertex of insertion and deletion of an edge or a change in the weight of an edge. The machine model used is a parallel random-access machine which allows simultaneous reads but prohibits simultaneous writes into the same memory location. The algorithms described in this paper require O(log n) time and use O(N-cubed) processors. These algorithms are efficient when compared to previously known 0(log-squared of n) time start-over algorithms for initial computation of the above-mentioned properties of graphs. The previous solution is maintained in multiple inverted trees (a rooted tree where a child node points toward its parent) and after a minor change the new solution is rapidly recomputed from these trees

39439 (AD-A—166062/0/XAB) Sequential and parallel matrix computations. Interim report, 1 September 1984-31 August 1985. Datta, B.N. (Northern Illinois Univ., Dekalb (USA)). Nov 1985. 6p. NTIS, PC A02/MF A01.

The major objectives of this project are to develop computational algorithms, both sequential and parallel, for several important linear-algebra problems that arise in the design and analysis of linear control systems governed by the systems of ordinary differential equations. These include controllability problems, stability and inertia problems, pole assignment problems, matrix equations problems, relative primeness of polynomials and matrices and the Cauchy-index problems of rational functions, etc. Besides, a part of the project is devoted to the theoretical study of the parallel arithmetic complexity of these problems; that is, how fast these problems can be solved in parallel assuming that sufficiently many processors are available. Though some numerically viable sequential algorithms have been designed for some of these problems in recent years, parallel algorithms and algorithms for large-scale problems are virtually nonexistent.

39440 (AD-A—166095/0/XAB) Parallel matrix computations. Interim report, 1983-1984. Stewart, G.W.; O'Leary, D.P. (Maryland Univ., College Park (USA). Dept. of Computer Science). 28 Mar 1985. 13p. NTIS, PC A02/MF A01.

This project concerns the design and analysis of algorithms to be run in a processor-rich environment. Focus is primarily on algorithms that require no global control and that can be run on systems with only local connections among processors. Properties of these algorithms are investigated both theoretically and experimentally. The experimental work is done on the ZMOB, a working parallel computer operated by the Laboratory for Parallel Computation of the Computer Science Department at the University of Maryland. To give the work direction, the authors focused on two areas: 1. dense problems from numerical linear algebra; and 2. the iterative and direct solution of sparse linear systems. The ZMOB hardware and the research projects pursued under this grant support are discussed.

39441 (ANL—85-63) Transforming Fortran DO loops to improve performance on vector architectures. Cowell, W.R.; Thompson, C.P. (Argonne National Lab., IL (USA)). May 1986. Contract W-31-109-ENG-38. 39p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012086.

The performance of programs executing on vector computers is significantly improved when the number of accesses to memory can be reduced. Unrolling Fortran DO loops, followed by substitutions and eliminations in the unrolled code, can reduce the number of loads and stores. The unrolling transformation and associated transformations of Fortran DO loops are characterized, and a set of software tools to carry out these transformations is described. The tools use the machinery available in Toolpack and have been integrated into that environment. The results of applying these tools to a collection of linear algebra subroutines are included. 7 refs., 2 figs.

39442 (CONF-860848—2) Psychology of developing and designing expert systems. Tonn, B.; MacGregor, D. (Oak Ridge National Lab., TN (USA); Decision Research, Eugene, OR (USA)). 1986. Contract AC05-84OR21400. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010019.

From National conference on artificial intelligence; Philadelphia, PA, USA (11 Aug 1986).

This paper discusses psychological problems relevant to developing and designing expert systems. With respect to the former, the psychological literature suggests that several cognitive biases may affect the elicitation of a valid knowledge base from the expert. The literature also suggests that common expert system inference engines may be quite inconsistent with reasoning heuristics

employed by experts. With respect to expert system user interfaces, care should be taken when eliciting uncertainty estimates from users, presenting system conclusions, and ordering questions.

30443 (N—86-19008) Partitioning and packing mathematical simulation models for calculation on parallel computers. Arpasi, D.J.; Milner, E.J. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1986. 38p. (NASA-TM—87170; E—2808; CONF-860877—1). NTIS, PC A03/MF A01.

From International conference on parallel processing; St. Charles, IL, USA (19 Aug 1986).

The development of multiprocessor simulations from a serial set of ordinary differential equations describing a physical system is described. Degrees of parallelism (i.e., coupling between the equations) and their impact on parallel processing are discussed. The problem of identifying computational parallelism within sets of closely coupled equations that require the exchange of current values of variables is described. A technique is presented for identifying this parallelism and for partitioning the equations for parallel solution on a multiprocessor. An algorithm which packs the equations into a minimum number of processors is also described. The results of the packing algorithm when applied to a turbojet engine model are presented in terms of processor utilization.

30444 (SAND—86-0601) Specification and installation of a MILNET host. George, M. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 40p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86012731.

A MILNET host computer was specified and installed to meet the needs of the growing user community at Sandia. The configuration of this host is described from specification through installation and testing. Also included are descriptions of the MILNET network and administrative procedures for the system. 5 figs.

30445 (SOL—86-11) Need to do planning under uncertainty and the possibility of using parallel processors for this purpose. Dantzig, G.B. (Stanford Univ., CA (USA). Systems Optimization Lab.). Apr 1986. Contract AS03-76ER72018. 28p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86012158.

Progress in solving large-scale problems, especially those involving uncertainty is outlined. Solving stochastic dynamic programs with the aid of parallel processing is discussed. The mathematical structure of deterministic and stochastic planning problems is given. The author stresses the use of these techniques to solve politically relevant planning problems which involve a great deal of uncertainty. 30 refs. (DWL)

30446 (UCID—20761) Network evaluation for F-Division. Boyd, J.K.; Carr, R.B.; Lee, F.D. (Lawrence Livermore National Lab., CA (USA)). 16 May 1986. Contract W-7405-ENG-48. 19p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86012603.

This report contains an evaluation of the computer and computer network needs of F-Division. The main intent is to identify ways in which all computational aspects of F-Division might interact more effectively. This includes the physics, engineering, and clerical staffs. Consideration is given to usage of the Octopus computer system, computer control of experiments, data analysis, computer aided design (CAD) and word processing issues.

CORPORATE AUTHOR INDEX

In the Corporate Author Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.
Environmental assessment of a commercial boiler fired with a coal/waste plastic mixture. Volume 1. Technical results. Final report, July 1983-July 1984, 11:38806 (R;US)
Environmental assessment of a commercial boiler fired with a coal/waste plastic mixture. Volume 2. Data supplement. Final report, July 1983-July 1984, 11:38807 (R;US)
Environmental assessment of a reciprocating engine retrofitted with selective catalytic reduction. Volume 1. Technical results. Final report, March-December 1984, 11:38224 (R;US)
Environmental assessment of a reciprocating engine retrofitted with selective catalytic reduction. Volume 2. Data supplement. Final report, March-December 1984, 11:38225 (R;US)
Environmental assessment of an enhanced-oil-recovery steam generator equipped with an EPA (Environmental Protection Agency) heavy oil low-NOx burner. Volume 2. Data supplement. Final report, January 1984-January 1985, 11:38666 (R;US)

Advanced Research and Applications Corp., Sunnyvale, CA (USA)
Geometrical relationship between Kikucki line position and excitation error in electron diffraction, 11:38739 (R;US)

Advisory Group for Aerospace Research and Development, 92 - Neuilly-sur-Seine (France)
Special course on cryogenic technology for wind tunnel testing, 11:38544 (R;FR)

Aerojet Ordnance Co., Jonesboro, TN (USA)
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The notations in the final parentheses indicate the type of document, e.g., R for Report; the country of publication, e.g., US; and the language if other than English, e.g., In German. Tables of document types and country of publication codes appear after the indexes.

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processes applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept (e.g., Pipeline Quality Gas, see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed. Copies of DOE/TIC-7000, the Subject Thesaurus, are available from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161.

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AC21-83MC20122	**UCC Research Corp., Bristol, VA (USA)**	
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AC21-83MC20230	**Helipump Corp., Cleveland, OH (USA)**	
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AT06-79ER10405	**Institut fuer Kernphysik, KFA Juelich, D-5170 Juelich, West Germany**	
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FC07-84ID12495	**Physical Sciences, Inc., Andover, MA (USA)**	
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FG02-85ER13449	**Brigham Young Univ., Provo, UT (USA). Dept. of Physics and Astronomy**	
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4	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011977	MN -11	11:38792
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3	*See* DESY-85-113	DE86752064	MN -34D	11:39161
CONF-850982-	(2. annual Pittsburgh coal conference, Pittsburgh, PA, USA, 16-20 Sep 1985)			
2	*See* IS-M-565	E 1.99: DE86011434	MN -90i	11:37309
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4	*See* CONF-860805-9	E 1.99: DE86008856	MN -38	11:38622
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1	*See* SNIAS-52-430-101			11:37434
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CONF-8511146-	(Conference on indentation fracture and mechanical properties of ceramic fuels, waste ceramics and glasses, Karlsruhe, F.R. Germany, 11-12 Nov 1985)				
2	*See* PNL-SA-13907	E 1.99:	DE86011613	MN -70	11:38356
CONF-8511152-	(Shuttle environment and operations II conference, Houston, TX, USA, 13-15 Nov 1985)				
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12	*See* LBL-20288	E 1.99:	DE86012011	MN -95d	11:38160
13	NTIS. PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86012237	MN -58b	11:38144
CONF-851217-	(Materials Research Society meeting, Boston, MA, USA, 2-7 Dec 1985)				
67	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012239	MN -25	11:38228
CONF-860111-	(11. workshop on geothermal reservoir engineering, Stanford, CA, USA, 21-23 Jan 1986)				
9	*See* LBL-21254	E 1.99:	DE86011558	MN -66a	11:37810
CONF-860146-	(Radiobioassay and internal dosimetry workshop, Albuquerque, NM, USA, 20 Jan 1986)				
10	*See* PNL-SA-13626	E 1.99:	DE86011618	MN -41	11:38723
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8	*See* PNL-SA-13602	E 1.99:	DE86012647	MN -34A	11:39075

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3	*See* PNL-SA-13672	E 1.99:	DE86011623	MN -41	11:38724
CONF-860150-	(Winter condensed matter physics conference: frontiers in condensed matter X-ray physics, Aspen, CO, USA, 12-18 Jan 1986)				
4	*See* SLAC-PUB-3974	E 1.99:	DE86012043	MN -28	11:38686
5	*See* BNL-37890	E 1.99:	DE86011199	MN -34D	11:39125
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4	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011483	MN -21	11:39355
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CONF-860263-	(Society of Automotive Engineers international congress and exposition, Detroit, MI, USA, 24-28 Feb 1986)				
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6	*See* PNL-SA-13706	E 1.99:	DE86011105	MN -95a	11:38066
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52	*See* PNL-SA-13365	E 1.99:	DE86011621	MN -70	11:37619
CONF-860340-	(115. American Institute of Mining, Metallurgical and Petroleum Engineers annual meeting, New Orleans, LA, USA, 2-6 Mar 1986)				
5	*See* N-86-21658				11:38252
CONF-860396-	(Symposium on the many facets of heavy ion fusion reactions, Argonne, IL, USA, 24-26 Mar 1986)				
10	*See* LBL-21336	E 1.99:	DE86011561	MN -34C	11:39205
CONF-8603119-	(21. Rencontre de Moriond: strong interactions and gauge theories conference, Les Arcs, France, 16-22 Mar 1986)				
5	*See* LBL-21402	E 1.99:	DE86012066	MN -34D	11:39135
6	*See* DOE/ER/03072-36	E 1.99:	DE86010434	MN -34D	11:39128
CONF-8603124-	(4. meeting DOE/PNC joint working group on waste management, Richland, WA, USA, 10 Mar 1986)				
1-Summ.	*See* UNI-SA-169	E 1.99:	DE86010607	MN -70A	11:37657
CONF-8603127-	(American Institute of Physics conference, Monterey, CA, USA, 1 Mar 1986)				
1	*See* LA-UR-86-1423	E 1.99:	DE86010202	MN -34A	11:39072
CONF-8603128-	(17. California quality week conference, Santa Clara, CA, USA, 21-22 Mar 1986)				
1	*See* UCRL-94600	E 1.99:	DE86011640	MN -70	11:37630
CONF-8603129-	(3. international symposium on river sedimentation, Jackson, MS, USA, 31 Mar-14 Apr 1986)				
1	*See* PNL-SA-13539		TI86011135	MN -11	11:38908
CONF-8603131-	(4. SME robotic solutions in aerospace manufacturing conference, Orlando, FL, USA, 3-6 Mar 1986)				
1	*See* SAND-85-2262C		DE86005176	MN -38	11:38557
CONF-860405-	(10. annual symposium on energy from biomass and wastes, Washington, DC, USA, 7-10 Apr 1986)				
5	*See* SERI/TP-232-2957	E 1.99:	DE86010696	MN -61E	11:37703
CONF-860412-	(.3. European conference on controlled fusion and plasma heating, Schliersee, F.R. Germany, 14-18 Apr 1986)				
12	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012308	MN -20a	11:39307
Exc.	*See* LRP-289/86		DE86901417	MN -20	11:39313
CONF-860420-	(Fast burst reactor workshop, Albuquerque, NM, USA, 8-10 Apr 1986)				
4	*See* SAND-86-1011C	E 1.99:	DE86012163	MN -38	11:38582
CONF-860421-	(2. international conference on fusion reactor materials (ICFRM-2), Chicago, IL, USA, 13-17 Apr 1986)				
54	*See* PNL-SA-13513	E 1.99:	DE86011619	MN -20c	11:38291
55	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012131	MN -20c	11:38229
56	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012232	MN -20c	11:39356

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CONF-860425-	(191. American Chemical Society national meeting, New York, NY, USA, 13-18 Apr 1986)			
	Am. Chem. Soc., Div. Gas Fuel Chem., Prepr., 31: No. 2, 252-255(Apr 1986)			11:37707
	Am. Chem. Soc., Div. Gas Fuel Chem., Prepr., 31: No. 2, 183-188(Apr 1986)			11:38475
	Am. Chem. Soc., Div. Gas Fuel Chem., Prepr., 31: No. 2, 90-94(Apr 1986)			11:38537
28	*See* PNL-SA-13632	E 1.99: DE86011132	MN -90i	11:38958
34	*See* PNL-SA-13541	E 1.99: DE86011624	MN -41	11:37655
CONF-860426-	(Symposium on measurement of toxic air pollutants, Raleigh, NC, USA, 27-30 Apr 1986)			
3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86011499	MN -41	11:38892
4	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86011774	MN -41	11:38790
5	*See* LBL-21449	E 1.99: DE86012497	MN -38	11:38678
CONF-860447-	(American Institute of Chemical Engineers spring national meeting, New Orleans, LA, USA, 6-10 Apr 1986)			
5	*See* LBL-21372	E 1.99: DE86012013	MN -11	11:37312
CONF-8604165-	(International conference on heavy ion physics, Rochester, NY, USA, 21-22 Apr 1986)			
4	*See* DOE/ER/40048-156-L6	E 1.99: DE86010440	MN -34C	11:39304
5	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86012113	MN -34C	11:39257
CONF-8604176-	(Workshop on scientific applications and algorithm design for high speed computing, Champaign, IL, USA, 7-10 Apr 1986)			
2	*See* LBL-21470	E 1.99: DE86011557	MN -25	11:39281
CONF-8604180-	(ASA CO-WYO chapter spring meeting, Boulder, CO, USA, 18 Apr 1986)			
1	*See* RFP-3878	DE86009644	MN -41	11:38950
CONF-8604188-	(98. annual meeting of the Iowa Academy of Science, Waverly, IA, USA, 25-26 Apr 1986)			
1	*See* IS-M-583	E 1.99: DE86011402	MN -90i	11:37310
CONF-8604194-	(International symposium on three-body force in the three-nucleon system, Washington, DC, USA, 24-26 Apr 1986)			
3	*See* TRI-PP-86-19	DE86901485	MN -34D	11:39211
CONF-8604196-	(RSTN/NORESS research symposium, Las Vegas, NV, USA, 30 Apr-1 May 1986)			
1	*See* SAND-86-0938C	E 1.99: DE86010097	MN -11	11:38994
CONF-8604199-	(Spring meeting on hydrofracture tests of US salt, Baton Rouge, LA, USA, 20-22 Apr 1986)			
1	*See* SAND-86-1034C	E 1.99: DE86010096	MN -70	11:39007
CONF-8604201-	(Antimatter physics at low energies, Batavia, IL, USA, 10-12 Apr 1986)			
2	*See* LA-UR-86-2138	E 1.99: DE86012400	MN -34	11:38683
CONF-8604205-	(Meeting of the Society of Chemical Industry, Lancaster University, PA, USA, 10-11 Apr 1986)			
1	*See* RFP-3962	E 1.99: DE86010808	MN -70	11:37622
CONF-8604206-	(US/France workshop on assay instrumentation, Albuquerque, NM, USA, 28-30 Apr 1986)			
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010398	MN -38	11:38547
CONF-8604208-	(Utah-Sanibel symposium on the interface between electronic structure and dynamics, Salt Lake City, UT, USA, 21-25 Apr 1986)			
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012112	MN -4	11:39070
CONF-8604209-	(ADPA corrosion prevention and control conference, Williamsburg, VA, USA, 28-30 Apr 1986)			
1	*See* BNL-38043	E 1.99: DE86011537	MN -25	11:38227
CONF-8604210-	(3. international symposium on optical and optoelectrical applied science and engineering, Innsbruck, Austria, 14-18 Apr 1986)			
1	*See* IS-M-584	E 1.99: DE86011403	MN -34	11:38403
CONF-8604211-	(Atmospheric deposition symposium, Little Rock, AR, USA, 20-21 Apr 1986)			
1	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86012238	MN -11	11:38861
CONF-8604212-	(CIT cost review meeting, Princeton, NJ, USA, 23 Apr 1986)			
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86011756	MN -20	11:39359
CONF-8604213-	(International workshop on physics and engineering of computerized multidimensional imaging and processing, Newport Beach, CA, USA, 2-4 Apr 1986)			
1	*See* LBL-21276	E 1.99: DE86011303	MN -38	11:38641
CONF-8604214-	(6. annual AGU front range branch hydrology days, Fort Collins, CO, USA, 16 Apr 1986)			
1	*See* PNL-SA-13861	E 1.99: DE86011117	MN -11	11:38888
CONF-8604215-	(2. international conference on the use of fly ash, silica fume, slag and natural pozzolans in concrete, Madrid, Spain, 21-25 Apr 1986)			
1	*See* ECN-86-047		ND -90i	11:37307
CONF-860501-	(Conference on the science and technology of fast reactor safety, Channel Islands, UK, 12-16 May 1986)			
12	NTIS, PC A02; 3	DE86012123	MN -79p	11:38018
13	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012126	MN -79p	11:38019

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CONF-860506-	(International conference on heavy ion nuclear collisions in the fermi energy domain, Caen, France, 12-16 May 1986)			
1	*See* LBL-21452	E 1.99: DE86012019	MN -34C	11:39217
CONF-860510-	(Symposium on heavy ion fusion, Washington, DC, USA, 27-29 May 1986)			
7	*See* UCRL-94335	E 1.99: DE86012192	MN -21	11:39368
CONF-860515-	(EPS conference on computational physics - computing in plasma physics, Partenkirchen, F.R. Germany, 13-16 May 1986)			
2	*See* LRP-290/86	DE86901528	MN -20	11:39314
CONF-860520-	(Conference on charged particle optics, Los Alamos, NM, USA, 19-21 May 1986)			
2	*See* SLAC-PUB-3927	E 1.99: DE86011598	MN -28	11:38692
4	*See* SLAC-PUB-3957	E 1.99: DE86011159	MN -28	11:38693
CONF-860522-	(7. international conference on plasma surface interactions in controlled fusion devices, Princeton, NJ, USA, 5-9 May 1986)			
13	*See* DOE/ET/51013-181	E 1.99: DE86012256	MN -20a	11:39309
14	*See* SAND-86-0039C	E 1.99: DE86012174	MN -20a	11:39315
15	*See* SAND-85-2628C	E 1.99: DE86012165	MN -20c	11:39363
CONF-860528-	(8. annual symposium on safeguards and nuclear material management, Copenhagen, Denmark, 13-15 May 1986)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86011079	MN -34C	11:39225
CONF-860535-	(3. annual heat engines contractors' meeting, Morgantown, WV, USA, 6-8 May 1986)			
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012122	MN -90f	11:37829
CONF-860536-	(Technical meeting on fluid mechanics and chemistry of the combustion process, Cleveland, OH, USA, 5-6 May 1986)			
1	*See* N-86-21635			11:38535
CONF-860557-	(4. HYDROCOIN meeting, Tokai, Japan, 26-30 May 1986)			
1	*See* SAND-86-1264C	E 1.99: DE86011645	MN -70	11:37644
CONF-860575-	(2. conference on particle and nuclear physics, Lake Louise, Canada, 26-31 May 1986)			
4	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86011769	MN -34C	11:39256
6	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86011978	MN -34C	11:39245
8	*See* LA-UR-86-2098	E 1.99: DE86012410	MN -34C	11:39207
9	*See* LA-UR-86-2055	E 1.99: DE86012416	MN -34D	11:39132
10	*See* LA-UR-86-2217	E 1.99: DE86012431	MN -34C	11:39262
11	*See* LA-UR-86-2135	E 1.99: DE86012402	MN -34C	11:39184
12	*See* LA-UR-86-2197	E 1.99: DE86012436	MN -34D	11:39133
CONF-860583-	(International Committee for Future Accelerators workshop on superconducting magnets, Upton, NY, USA, 12-16 May 1986)			
1	*See* LBL-21549	E 1.99: DE86012499	MN -28	11:38705
CONF-8605117-	(International conference on the development of alternative energy sources and the lessons learned since the oil embargo, Grand Forks, ND, USA, 23-24 May 1986)			
3	*See* DOE/FE/60181-199	E 1.99: DE86010576	MN -90i	11:38796
CONF-8605127-	(10. annual actinide workshop, Los Alamos, NM, USA, 12-16 May 1986)			
1	*See* RFP-3936	E 1.99: DE86010807	MN -47	11:37620
2	*See* RFP-3937	E 1.99: DE86010803	MN -70	11:37621
CONF-8605130-	(Bilateral technical workshop on NRTMA, Hannover, F.R. Germany, 5-7 May 1986)			
1	*See* LA-UR-86-1394	E 1.99: DE86010196	MN -15	11:37670
CONF-8605132-	(10. international symposium on column liquid chromatography, San Francisco, CA, USA, 18-23 May 1986)			
2	*See* PNL-SA-13584	E 1.99: DE86012150	MN -4	11:38472
CONF-8605134-	(Interface working group on volume reduction, Savannah River, SC, USA, 5-7 May 1986)			
1	*See* EGG-M-12386	E 1.99: DE86011038	MN -70	11:37606
CONF-8605136-	(International Atomic Energy Agency meeting, Marcoule, France, 12-16 May 1986)			
1	*See* DOE/SSDP-0009	E 1.99: DE86011894	MN -78	11:37902
CONF-8605137-	(10. symposium on aquatic toxicology and hazard assessment, New Orleans, LA, USA, 4-6 May 1986)			
1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86011493	MN -11	11:38893
2	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86011765	MN -11	11:38894
3	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86011777	MN -90i	11:37328
CONF-8605139-	(Minimars review meeting, Toronto, Canada, 20 May 1986)			
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86011783	MN -20	11:39360
CONF-8605143-	(LINAC '86: logistics meeting, Stanford, CA, USA, 31 May-6 Jun 1986)			
1	*See* SAND-86-1240C	E 1.99: DE86011826	MN -28	11:38685
CONF-8605145-	(International conference on the physics of phase space, College Park, MD, USA, 20-23 May 1986)			
1	*See* LA-UR-86-1679	E 1.99: DE86011249	MN -34	11:39113

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CONF-8605146-	(15. Yamada conference on physics and chemistry of quasi one-dimensional conductors, Lake Kawaguchi, Japan, 26-30 May 1986)			
2	*See* LBL-21604	E 1.99: DE86011921	MN -34	11:38409
CONF-8605147-	(IAEA coordinated research program meeting on behavior of spent fuel assemblies in extended storage (BEFAST), Leningrad, USSR, 26-30 May 1986)			
1	*See* PNL-SA-13810	E 1.99: DE86011631	MN -85	11:37522
CONF-8605149-	(19. Jerusalem symposium on quantum chemistry and biochemistry, Jerusalem, Israel, 5-8 May 1986)			
1	*See* BNL-38135	E 1.99: DE86011541	MN -25	11:38490
CONF-860601-	(4. international conference on emerging nuclear energy systems, Madrid, Spain, 30 Jun-4 Jul 1986)			
3	*See* UCRL-93763	E 1.99: DE86012188	MN -21	11:39365
4	*See* UCRL-94609	E 1.99: DE86012353	MN -20	11:39370
5	*See* UCRL-94608	E 1.99: DE86012352	MN -20	11:39369
CONF-860602-	(17. rare earth research conference, Hamilton, Ontario, Canada, 8-12 Jun 1986)			
4	*See* LA-UR-86-2000	E 1.99: DE86012376	MN -4	11:38526
CONF-860604-	(International symposium on the packaging and transport of radioactive materials (PATRAM '86), Davos, Switzerland, 16-20 Jun 1986)			
22	*See* SAND-85-2206C	E 1.99: DE86011647	MN -71	11:37656
23	*See* SAND-85-2208C	E 1.99: DE86011648	MN -71	11:38556
24	*See* SAND-86-1295C	E 1.99: DE86011646	MN -71	11:37524
25	*See* IAEA-SM-286/213	E 1.99: DE86011752	MN -71	11:37520
26	*See* SAND-86-0054C	E 1.99: DE86011180	MN -71	11:37523
27	*See* PNL-SA-13430	E 1.99: DE86012151	MN -71	11:37521
CONF-860605-	(13. international symposium on the effects of radiation on materials, Seattle, WA, USA, 23-25 Jun 1986)			
14	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012201	MN -70B	11:38401
15	*See* PNL-SA-13727	E 1.99: DE86012329	MN -79b	11:37936
16	*See* PNL-SA-13913	E 1.99: DE86012326	MN -25	11:38292
CONF-860606-	(Air Pollution Control Association annual meeting and exhibition, Minneapolis, MN, USA, 22-27 Jun 1986)			
7	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86011506	MN -11	11:38791
8	*See* LBL-21355	E 1.99: DE86011553	MN -41	11:37311
CONF-860607-	(8. annual energy technology conference, Houston, TX, USA, 17-19 Jun 1986)			
2	*See* LA-UR-86-2044	E 1.99: DE86012368	MN -93A	11:38138
CONF-860608-	(World congress on high tech ceramics: electronic, engineering, nuclear, biomedical research and applications in focus, Milan, Italy, 23-27 Jun 1986)			
2	*See* LA-UR-86-2232	E 1.99: DE86012429	MN -25	11:38406
CONF-860609-	(27. U.S. symposium on rock mechanics, Tuscaloosa, AL, USA, 23-25 Jun 1986)			
16	*See* PNL-SA-13816	E 1.99: DE86012332	MN -70	11:39005
CONF-860610-	(American Nuclear Society annual meeting, Reno, NV, USA, 15-20 Jun 1986)			
28	*See* UCRL-93848	E 1.99: DE86012356	MN -21	11:39366
CONF-860612-	(4. AIAA/ASME thermophysics and heat transfer conference, Boston, MA, USA, 2-4 Jun 1986)			
8	*See* SAND-86-1412C	E 1.99: DE86012169	MN -38	11:38626
CONF-860620-	(Society of Photo-Optical Instrumentation Engineers international symposium: topics in optical and optoelectronic applied sciences and engineering, Quebec City, Canada, 2-6 Jun 1986)			
8	*See* SAND-85-2830C	E 1.99: DE86012175	MN -25	11:38411
CONF-860629-	(Linear accelerator conference, Stanford, CA, USA, 2-6 Jun 1986)			
14	*See* LA-UR-86-1195	E 1.99: DE86012397	MN -28	11:38689
15	*See* LA-UR-86-1773	E 1.99: DE86012394	MN -28	11:38690
CONF-860636-	(15. international symposium on rarefied gas dynamics, Grado, Italy, 16-20 Jun 1986)			
2	*See* UCRL-93698	E 1.99: DE86011888	MN -22	11:37688
3	*See* LA-UR-86-1943	E 1.99: DE86012383	MN -34A	11:39073
CONF-860648-	(6. annual contractors' meeting on contaminant control in coal-derived gas streams, Morgantown, WV, USA, 4-5 Jun 1986)			
2	*See* PNL-SA-13970	E 1.99: DE86012152	MN -90c	11:37276
CONF-860649-	(6. annual gasification contractors' meeting, Morgantown, WV, USA, 24-25 Jun 1986)			
4	*See* LA-UR-86-2127	E 1.99: DE86012404	MN -90c	11:37272
5	*See* DOE/FE/60181-215	E 1.99: DE86010899	MN -90	11:37265
CONF-860652-	(7. topical meeting on the technology of fusion energy, Reno, NV, USA, 15-19 Jun 1986)			
6	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86012230	MN -20a	11:39357
7	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86012620	MN -20b	11:39358
CONF-860654-	(27. annual meeting of the Institute of Nuclear Materials Management, New Orleans, LA, USA, 22-25 Jun 1986)			
5	*See* SAND-86-0865C	E 1.99: DE86011829	MN -11	11:38854

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6	*See* SAND-86-0655C	E 1.99:	DE86011816	MN -15	11:37684
8	*See* SAND-86-0653C	E 1.99:	DE86012176	MN -15	11:37682
9	*See* SAND-86-0654C	E 1.99:	DE86012177	MN -15	11:37683
11	*See* LA-UR-86-2122	E 1.99:	DE86012405	MN -15	11:37675
13	*See* SAND-86-1104C	E 1.99:	DE86012170	MN -78	11:37860
14	*See* LA-UR-86-2088	E 1.99:	DE86012411	MN -15	11:37672
15	*See* LA-UR-86-2099	E 1.99:	DE86012409	MN -15	11:37673
17	*See* LA-UR-86-2108		TI86012408	MN -15	11:37674
18	*See* SAND-86-0702C	E 1.99:	DE86012172	MN -15	11:37687
19	*See* PNL-SA-13897	E 1.99:	DE86012146	MN -16	11:37680
20	*See* SAND-86-0693C	E 1.99:	DE86012171	MN -15	11:37686
21	*See* LA-UR-86-2282	E 1.99:	DE86012420	MN -15	11:37678
22	*See* LA-UR-86-2187	E 1.99:	DE86012438	MN -15	11:37676
23	*See* LA-UR-86-2032	E 1.99:	DE86012371	MN -15	11:37671
24	*See* LA-UR-86-2034	E 1.99:	DE86012370	MN -2	11:39436
25	*See* LA-UR-86-2189	E 1.99:	DE86012437	MN -15	11:37677
26	*See* LA-UR-86-2220	E 1.99:	DE86012430	MN -16	11:38471
27	*See* SAND-86-0662C	E 1.99:	DE86011650	MN -15	11:37685
CONF-860655-	(American Solar Energy Society annual meeting and 11. national passive solar conference, Boulder, CO, USA, 8-14 Jun 1986)				
11	*See* PNL-SA-13565	E 1.99:	DE86012149	MN -63	11:37729
12	*See* PNL-SA-13915	E 1.99:	DE86012147	MN -62	11:38070
13	*See* PNL-SA-13968	E 1.99:	DE86012148	MN -58	11:37730
CONF-860658-	(Personal computers: gas industry applications, Las Vegas, NV, USA, 18-20 Jun 1986)				
1	*See* PNL-SA-14013	E 1.99:	DE86012153	MN -92	11:37490
CONF-860665-	(6. international conference on high power particle beams, Kobe, Japan, 9-12 Jun 1986)				
5	*See* LA-UR-86-1987	E 1.99:	DE86012377	MN -28	11:38702
CONF-860674-	(17. power modulator symposium, Seattle, WA, USA, 23-25 Jun 1986)				
3	*See* SAND-86-0301C	E 1.99:	DE86012283	MN -38	11:38646
4	*See* SAND-86-0434C	E 1.99:	DE86012282	MN -38	11:38647
5	*See* SAND-86-0519C	E 1.99:	DE86012281	MN -38	11:38649
7	*See* SAND-86-0512C	E 1.99:	DE86012279	MN -38	11:38648
8	*See* UCRL-94757	E 1.99:	DE86012189	MN -38	11:38654
CONF-860676-	(3. international Stirling engine conference, Rome, Italy, 1 Jun 1986)				
2	*See* DOE/NASA/1005-8	E 1.99:	DE86006660	STD -80	11:37947
CONF-860688-	(32. NASA/US Army international power sources symposium, Cherry Hill, NJ, USA, 8-12 Jun 1986)				
3	*See* N-86-21978				11:38073
CONF-860695-	(HazMat '86: hazardous materials management conference and exhibition, Atlantic City, NJ, USA, 2-4 Jun 1986)				
3	*See* UCRL-94541	E 1.99:	DE86011635	MN -41	11:38562
CONF-8606121-	(International symposium on ultrasonics, ferroelectrics and frequency control, Bethlehem, PA, USA, 9-11 Jun 1986)				
2	*See* SAND-85-2748C	E 1.99:	DE86011643	MN -38	11:38645
CONF-8606125-	(ASHRAE annual meeting, Portland, OR, USA, 22-25 Jun 1986)				
2	*See* LBL-19237	E 1.99:	DE86011556	MN -95d	11:38157
3	*See* PNL-SA-13941	E 1.99:	DE86012327	MN -95d	11:38174
4	*See* PNL-SA-13904	E 1.99:	DE86012328	MN -95d	11:38173
5	*See* PNL-SA-13739	E 1.99:	DE86012325	MN -95d	11:38172
CONF-8606129-	(DOSECC workshop on continental scientific drilling program, Rapid City, SD, USA, 12-14 Jun 1986)				
1	*See* UCRL-94566	E 1.99:	DE86010979	MN -66a	11:37812
CONF-8606130-	(International conference on nuclear structure, reactions, and symmetries, Dubrovnik, Yugoslavia, 5-14 Jun 1986)				
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011770	MN -34C	11:39258
CONF-8606131-	(2. international topical symposium on ICF research by high-power beams, Nagaoka, Japan, 16-18 Jun 1986)				
1	*See* LA-UR-86-2045	E 1.99:	DE86012415	MN -21	11:39362
CONF-8606132-	(10. U.S. National Congress of Applied Mechanics conference, Austin, TX, USA, 16-18 Jun 1986)				
1	*See* LA-UR-86-2065	E 1.99:	DE86012414	MN -25	11:38245
CONF-8606133-	(International conference on science and technology of synthetic metals, Kyoto, Japan, 1-6 Jun 1986)				
2	*See* LA-UR-86-1565	E 1.99:	DE86011263	MN -25	11:38393
3	*See* LA-UR-86-1744	E 1.99:	DE86011218	MN -25	11:38394
4	*See* SAND-86-0162C	E 1.99:	DE86011416	MN -34	11:38756
CONF-8606134-	(4. international conference on muon spin rotation, relaxation and resonance, Uppsala, Sweden, 1 Jun 1986)				
1	*See* LA-UR-86-2199	E 1.99:	DE86012435	MN -25	11:38247
2	*See* LA-UR-86-2157	E 1.99:	DE86012398	MN -34D	11:38246
3	*See* LA-UR-86-2158	E 1.99:	DE86012446	MN -25	11:38405

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CONF-8606137-	(30. anniversary symposium of the Institute of Mechanics, Beijing, China, 8-9 Jun 1986)			
1	*See* SAND-86-1321C	E 1.99: DE86011653	MN -38	11:38542
CONF-860703-	(4. international conference on megagauss magnetic-field generation and related topics, Santa Fe, NM, USA, 14-17 Jul 1986)			
2	*See* LA-UR-86-2084	E 1.99: DE86012413	MN -38	11:38738
3	*See* LA-UR-86-2268	E 1.99: DE86012423	MN -38	11:38552
4	*See* UCRL-93825	E 1.99: DE86012357	MN -38	11:38561
5	*See* LA-UR-86-1975	E 1.99: DE86012380	MN -38	11:38752
CONF-860705-	(IEEE Power Engineering Society summer meeting, Mexico City, Mexico, 20-25 Jul 1986)			
3	*See* LA-UR-86-2184	E 1.99: DE86012439	MN -97c	11:38062
CONF-860724-	(ASME/ANS bi-annual nuclear power conference: safe and reliable nuclear power plants, Philadelphia, PA, USA, 20-23 Jul 1986)			
3	*See* DOE/SSDP-0008	E 1.99: DE86011895	MN -78	11:37901
4	*See* DOE/SSDP-0004	E 1.99: DE86011892	MN -78	11:37897
5	*See* DOE/SSDP-0006	E 1.99: DE86011890	MN -78	11:37899
6	*See* DOE/SSDP-0003	E 1.99: DE86011893	MN -78	11:37896
7	*See* DOE/SSDP-0005	E 1.99: DE86011891	MN -78	11:37898
8	*See* DOE/SSDP-0007	E 1.99: DE86011760	MN -78	11:37900
9	*See* GA-A-18408	E 1.99: DE86012103	MN -77	11:37930
CONF-860741-	(International symposium on weak and electromagnetic interactions in nuclei, Heidelberg, F.R. Germany, 1-5 Jul 1986)			
1-Rev.1	*See* UCRL-94158-Rev.1	E 1.99: DE86012354	MN -34C	11:39234
4	*See* UCRL-94252	E 1.99: DE86011882	MN -34C	11:38783
5	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012233	MN -34C	11:39246
6	*See* LA-UR-86-2283	E 1.99: DE86012419	MN -34D	11:39134
CONF-860803-	(7. world clean air congress and exhibition, Sydney, Australia, 25-29 Aug 1986)			
2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86007506	MN -11	11:38087
3	*See* UCRL-92534	E 1.99: DE86010977	MN -11	11:38858
4	*See* TNO-CMP-86-01		ND -11	11:38830
CONF-860804-	(21. international symposium on combustion, Munich, F.R. Germany, 3-8 Aug 1986)			
3	*See* DOE/FE/60181-182	E 1.99: DE86006127	MN -90	11:37367
8	*See* SAND-86-0033	E 1.99: DE86006467	MN -34	11:38755
9	*See* LBL-20863	E 1.99: DE86007490	MN -34	11:38532
10	*See* LBL-20878	E 1.99: DE86007496	MN -90e	11:38212
CONF-860805-	(International heat transfer conference, San Francisco, CA, USA, 17-22 Aug 1986)			
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86001356	MN -25	11:38230
3	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86003064	MN -38	11:38620
4	*See* SAND-85-1552C	E 1.99: DE86004603	MN -38	11:38623
5	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99: DE86005516	MN -90	11:37363
6	*See* SAND-86-0021C	E 1.99: DE86006471	MN -38	11:38624
7	*See* SERI/TP-252-2812	E 1.99: DE86004424	MN -59B	11:37793
8	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86007514	MN -38	11:38621
9	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86008856	MN -38	11:38622
CONF-860809-	(International conference on low-energy dislocation structures, Charlottesville, VA, USA, 10-13 Aug 1986)			
1	*See* DOE/ER/45098-11	E 1.99: DE86002968	MN -25	11:38237
2	*See* LA-UR-85-4231	E 1.99: DE86004728	MN -25	11:38242
CONF-860810-	(Intersociety energy conversion engineering conference, San Diego, CA, USA, 25-29 Aug 1986)			
2	*See* SAND-86-0004C	DE86010482	MN -62	11:37801
5	*See* LA-UR-86-1840	E 1.99: DE86011235	MN -93	11:38065
6	*See* LA-UR-86-1548	E 1.99: DE86011264	MN -93	11:38681
8	*See* EGG-M-10186	E 1.99: DE86011037	MN -95f	11:38193
9	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86011070	MN -94	11:38063
11	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86011511	MN -94a	11:38064
12	*See* SAND-86-7102C	E 1.99: DE86011424	MN -94cb	11:38074
13	*See* LBL-20180	E 1.99: DE86011923	MN -94a	11:38066
14	*See* PSI-560/SR-261	E 1.99: DE86011952	MN -95f	11:38141
15	*See* LBL-21548	E 1.99: DE86012018	MN -94	11:38067
CONF-860816-	(3. U.S. national conference on earthquake engineering, Charleston, SC, USA, 24-28 Aug 1986)			
1	*See* BNL-NUREG-38048	TI86011198	MN -11	11:37993
CONF-860818-	(American Council for an Energy Efficient Economy Santa Cruz summer study on energy-efficiency in buildings, Santa Cruz, CA, USA, 17-23 Aug 1986)			
1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010034	MN -95d	11:38145
CONF-860822-	(12. annual symposium on underground coal gasification, Saarbrucken, F.R. Germany, 25-28 Aug 1986)			
1	*See* SAND-86-0749C	E 1.99: DE86012162	MN -90c	11:37277
CONF-860826-	(National meeting of the American Institute of Chemical Engineers, Boston, MA, USA, 24-27 Aug 1986)			
1	*See* DP-MS-86-17	E 1.99: DE86010316	MN -70	11:37605
2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86012618	MN -70B	11:38402

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CONF-860829-	(Annual joint meeting of the Electron Microscopy of America and the Microbeam Analysis Society, Albuquerque, NM, USA, 10-15 Aug 1986)			
1	*See* LA-UR-86-796	E 1.99: DE86007362	MN -25	11:38243
2	*See* LA-UR-86-797	E 1.99: DE86007361	MN -25	11:38244
3	*See* SAND-86-0251C	E 1.99: DE86007627	MN -25	11:38293
4	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86008494	MN -25	11:38231
5	*See* SAND-86-0237C	E 1.99: DE86007628	MN -25	11:39012
6	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86008537	MN -25	11:38232
7	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86008532	MN -37	11:38735
8	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86008533	MN -37	11:38736
9	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86008340	MN -25	11:38233
10	*See* SAND-86-0609C	E 1.99: DE86008406	MN -25	11:38412
11	*See* SAND-86-0779C	E 1.99: DE86008781	MN -25	11:38295
15	*See* SAND-86-0806C	E 1.99: DE86009030	MN -25	11:38492
16	*See* SAND-86-0567C	E 1.99: DE86009023	MN -25	11:38294
17	*See* SAND-86-0812C	E 1.99: DE86009284	MN -25	11:38296
18	*See* SAND-86-0921C	E 1.99: DE86009540	MN -34A	11:38741
19	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009537	MN -25	11:38388
20	*See* SAND-86-0962C	E 1.99: DE86009637	MN -20	11:39364
21	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009353	MN -25	11:38351
22	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86009421	MN -25	11:38234
23	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86009538	MN -25	11:38226
24	*See* SAND-86-0975C	DE86010468	MN -25	11:38297
25	*See* SAND-86-1032C	E 1.99: DE86010459	MN -25	11:38473
27	*See* LBL-21287	E 1.99: DE86011308	MN -25	11:38248
28	*See* LBL-21356	E 1.99: DE86011314	MN -25	11:38407
29	*See* LBL-21431	E 1.99: DE86011586	MN -25	11:38408
30	*See* LBL-21315	E 1.99: DE86012012	MN -25	11:38739
CONF-860839-	(36. International Institution for Production Engineering Research general assembly, Jerusalem-Haifa, Israel, 16-22 Aug 1986)			
2	*See* UCRL-94273	E 1.99: DE86009398	MN -38	11:38627
CONF-860840-	(ICMC/cryogenic engineering conference, Cambridge, MA, USA, 12-16 Aug 1986)			
1	*See* FNAL-TM-1387	E 1.99: DE86008121	STD -38	11:38549
CONF-860841-	(World conference on robotics research, Scottsdale, AZ, USA, 19-21 Aug 1986)			
1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86008226	MN -38	11:38545
2	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86008236	MN -38	11:38546
CONF-860848-	(National conference on artificial intelligence, Philadelphia, PA, USA, 11-15 Aug 1986)			
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010019	MN -13	11:39442
CONF-860849-	(URSI international symposium on electromagnetic theory in Budapest, Budapest, Hungary, 25-29 Aug 1986)			
1	*See* UCRL-93482	E 1.99: DE86008768	MN -38	11:38560
CONF-860854-	(11. international congress on electron microscopy, Kyoto, Japan, 31 Aug-7 Sep 1986)			
1	*See* CONF-860829-22	E 1.99: DE86009421	MN -25	11:38234
2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009306	MN -25	11:38352
3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010027	MN -25	11:38235
CONF-860855-	(3. international drying symposium (IDS '86), Cambridge, MA, USA, 13-16 Aug 1986)			
1	*See* DOE/FE/60181-179	E 1.99: DE86010105	MN -90	11:37354
CONF-860872-	(8. IEEE non-volatile semiconductor memory workshop, Vail, CO, USA, 18-20 Aug 1986)			
1	*See* SAND-86-2079C	E 1.99: DE86010483	MN -38	11:38652
2	*See* SAND-86-1160C	E 1.99: DE86010953	MN -38	11:38650
CONF-860874-	(2. international photovoltaic science and engineering conference, Beijing, China, 1 Aug 1986)			
1	*See* SAND-86-2035C	E 1.99: DE86010467	MN -63	11:37766
2	*See* SERI/TP-211-2960	DE86010702	MN -63	11:37741
CONF-860877-	(International conference on parallel processing, St. Charles, IL, USA, 19-22 Aug 1986)			
1	*See* N-86-19008			11:39443
CONF-860878-	(2. annual symposium and exposition on physical and electronic security, Philadelphia, PA, USA, 19-21 Aug 1986)			
1	*See* LA-UR-86-1813	E 1.99: DE86011240	MN -38	11:38550
CONF-860879-	(International conference on martensitic transformations (ICOMAT-86), Nara, Japan, 26-30 Aug 1986)			
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86011781	MN -25	11:38236
CONF-860880-	(30. SPIE technical symposium on optics and optoelectronic engineering, San Diego, CA, USA, 17-22 Aug 1986)			
1	*See* KMSF-U-1761	E 1.99: DE86011867	MN -21	11:38404
2	*See* LA-UR-86-2214	E 1.99: DE86012432	MN -28	11:38703
3	*See* UCRL-94096	E 1.99: DE86012355	MN -34A	11:39076
4	*See* LA-UR-86-2254	E 1.99: DE86012427	MN -38	11:38579
5	*See* LA-UR-86-2014	E 1.99: DE86012372	MN -38	11:38578
6	*See* LA-UR-86-2255	E 1.99: DE86012426	MN -37	11:39279
7	*See* UCRL-93846	E 1.99: DE86012350	MN -37	11:39280
8	*See* UCRL-94097	E 1.99: DE86012340	MN -21	11:39367

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9	*See* UCRL-94116	E 1.99:	DE86012351	MN -37	11:38728
10	*See* UCRL-94098	E 1.99:	DE86012349	MN -37	11:38727
CONF-860881-	(Asia Pacific regional conference on translation, Kuala Lumpur, Malaysia, 17 Aug 1986)				
1	*See* SAND-86-1485C	E 1.99:	DE86012285	MN -13	11:39431
CONF-860882-	(Atmospheric flight mechanics conference, Williamsburg, VA, USA, 18-20 Aug 1986)				
1	*See* SAND-86-0158C		DE86011185	MN -38	11:38625
2	*See* SAND-86-2061C	E 1.99:	DE86010989	MN -38	11:38558
CONF-860883-	(Ceramic powder science and technology, Boston, MA, USA, 3-6 Aug 1986)				
1	*See* LA-UR-86-2130	E 1.99:	DE86012403	MN -25	11:38353
CONF-860996-	(IEEE international test conference, Washington, DC, USA, 8-11 Sep 1986)				
1	*See* SAND-86-1379C	E 1.99:	DE86012168	MN -38	11:38651
CONF-861091-	(Hypervelocity impact symposium, San Antonio, TX, USA, 21-24 Oct 1986)				
1	*See* LA-UR-86-2112	E 1.99:	DE86012407	MN -38	11:38551
CSIR/SR/HOUT-					
370	*See* PB-86-192374/XAB				11:37702
383	*See* PB-86-189651/XAB				11:37711
385	*See* PB-86-189644/XAB				11:37701
388	*See* PB-86-188976/XAB				11:37700
DAS-					
171	*See* CEA-CONF-8169		DE86752447	MN -11	11:38986
DESY-					
85-101	NTIS (US Sales Only), PC A02/MF A01		DE86752070	MN -34D	11:39181
85-105	NTIS (US Sales Only), PC A02/MF A01		DE86752071	MN -34D	11:39182
85-108	NTIS (US Sales Only), PC A02/MF A01		DE86752072	MN -34D	11:39195
85-110	NTIS (US Sales Only), PC A05/MF A01		DE86752073	MN -34D	11:39160
85-113	NTIS (US Sales Only), PC A03/MF A01		DE86752064	MN -34D	11:39161
85-115	NTIS (US Sales Only), PC A03/MF A01		DE86752065	MN -34D	11:39126
85-118	NTIS (US Sales Only), PC A02/MF A01		DE86752066	MN -34D	11:39183
85-119	NTIS (US Sales Only), PC A02/MF A01		DE86752069	MN -34D	11:39127
85-122	NTIS (US Sales Only), PC A02/MF A01		DE86752067	MN -34D	11:39162
85-124	NTIS (US Sales Only), PC A02/MF A01		DE86752068	MN -34D	11:39163
85-133	NTIS (US Sales Only), PC A04/MF A01		DE86752075	MN -34D	11:39164
85-134	NTIS (US Sales Only), PC A02/MF A01		DE86752074	MN -34D	11:39165
DFVLR-FB-					
84-43	*See* ESA-TT-12				11:38185
85-09	*See* ESA-TT-24				11:38840
DGMK-					
295	NTIS PC E09; Available from NTIS as TIB/B86-06438			ND -92a	11:37419
295-1	NTIS PC E14; Available from NTIS as TIB/B86-06437			ND -92a	11:37420
295-3	NTIS PC E09; Available from NTIS as TIB/B86-06439			ND -92a	11:37421
295-5	NTIS PC E09; Available from NTIS as TIB/B86-06440			ND -92a	11:37422
DOE/BC-					
85/ 3	NTIS, PC A06/MF A01 (GPO Dep.)	E 1.99:	DE86000259	STD -92a	11:37423
DOE/BC/10508-					
36	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86000274	STD -92a	11:37424
DOE/BC/10824-					
2	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86007849	MN -90	11:37263
DOE/BP-					
575	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012268	MN -95d	11:38146
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DOE/BP/13499-					
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DOE/BP/16687-					
2	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011728	MN -11	11:37720
DOE/BP/16726-					
1	NTIS, PC A11/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011440	MN -11	11:38944
DOE/BP/17060-					
1	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012271	MN -95d	11:38147
DOE/BP/18246-					
1	NTIS, PC A14/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011939	MN -95d	11:38148
DOE/BP/18969-					
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2	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011674	MN -11	11:37722
3	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011725	MN -11	11:37723
4	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011711	MN -11	11:37724
5	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011707	MN -11	11:37725
7	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011731	MN -11	11:37726
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1	NTIS, PC A14/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012472	MN -98E	11:38111
DOE/BPA-					
22209-2	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86011675	MN -11	11:38887
DOE/CE-					
0027/ 4	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010883	MN -96	11:38211

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0156	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011740	MN -66	11:37809
DOE/CE/30701- T7	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011857	MN -63	11:37763
T8	NTIS, PC A02/MF 01; 1 (GPO Dep.)	E 1.99:	DE86011858	MN -63	11:37764
DOE/CE/30784- H3	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86012087	MN -95e	11:38192
DOE/CE/40772- T2	NTIS, PC A05/MF A01; 1		DE86009761	MN -61F	11:37705
DOE/CE/63428- T1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012053	MN -95	11:38149
DOE/CE/64855- T1	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86010057	MN -95	11:38150
DOE/CS/20043- T6	NTIS, PC A99/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010124	MN -95d	11:38151
DOE/CS/30636- 1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012314	MN -59B	11:37799
DOE/DP- 0030	NTIS, PC A02/MF A01; 1		DE86011729	STD -71	11:37519
DOE/DP/03533- T9	NTIS, PC A06/MF A01 (GPO Dep.)	E 1.99:	DE86011478	MN -70	11:37597
DOE/EIA- 0035(86/ 03)	NTIS, PC A07/MF A01; 1 - GPO (GPO Dep.)	E 1.99:	DE86012577	MN -98	11:37466
0109(86/ 04)	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012301	MN -98B	11:37467
0204(86/ 03)	NTIS, PC A03/MF A01; 1 - GPO (GPO Dep.)	E 1.99:	DE86012687	MN -98	11:38099
0340(85) / 2	NTIS, PC A19/MF A01; 1 - GPO (GPO Dep.)	E 1.99:	DE86011815	MN -98B	11:37468
DOE/EIS- 0115D	NTIS, PC A11/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010617	MN -11	11:37638
0123F	NTIS, PC A14/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011907	MN -11	11:38922
DOE/EP/12067- H1-Summ.	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012392	MN -90i	11:37839
H1-Vol.1	NTIS, PC A16/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012651	MN -90i	11:37840
H1-Vol.2-Pt.1	NTIS, PC A99/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012484	MN -90i	11:37852
H1-Vol.2-Pt.2	NTIS, PC A99/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012485	MN -90i	11:37853
DOE/ER- 0277	NTIS, PC A09/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012461	STD -13	11:38983
DOE/ER/03072- 36	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010434	MN -34D	11:39128
DOE/ER/03230- T5	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86012491	MN -34D	11:39129
DOE/ER/10663- T2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012205	MN -34D	11:39130
DOE/ER/13193- 2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012508	MN -4	11:38512
DOE/ER/13244- T1	NTIS, PC A02/MF A01; 3		DE86008583	MN -90	11:37352
T2	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011979	MN -90	11:37291
DOE/ER/40048- 156-L6	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010440	MN -34C	11:39304
DOE/ER/45050- 1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012509	MN -34A	11:39071
DOE/ER/45098- 11	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86002968	MN -25	11:38237
DOE/ER/53194- 01	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012207	MN -34	11:39308
DOE/ER/53198- 95	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012666	MN -20b	11:39361
DOE/ER/54025- T2	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012270	MN -20	11:39306
DOE/ER/60119- T3	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86011814	MN -41	11:37646
DOE/ER/60152- 1	NTIS, PC A19/MF A01 - GPO		TI86011466	MN -11	11:38984
DOE/ER/60227- T1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011551	MN -11	11:38794
DOE/ER/60306- 1	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012097	MN -11	11:38795
DOE/ER/64780- T1	NTIS, PC A02/MFA 01 (GPO Dep.)	E 1.99:	DE86011745	MN -95a	11:38084
DOE/ER/80170- T1	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86011945	MN -70	11:37598
DOE/ET- 15425-T1	NTIS$8.00				11:37830
DOE/ET/51013- 181	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012256	MN -20a	11:39309
184	NTIS, PC A14/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012587	MN -20	11:39310
DOE/ET/53018- 13	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011919	MN -20	11:39311
DOE/EV/01826- 54	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012321	MN -41	11:37647
DOE/EV/03490- 2530	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011966	MN -41	11:38946
DOE/EV/03522- T4	NTIS, PC A09/MF A01; 1 (GPO Dep.)	E 1.99:	DE86006947	MN -41	11:38717

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DOE/EV/04318-6	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86011283	MN -48	11:38937
DOE/EV/04969-T2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86011573	MN -48	11:38938
DOE/FE-0011	NTIS$6.50			11:37264
0060	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99: DE86011955	MN -90i	11:38088
0063	NTIS, PC A11/MF A01; 1 (GPO Dep.)	E 1.99: DE86012639	MN -90j	11:37353
DOE/FE/60181-179	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010105	MN -90	11:37354
182	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86006127	MN -90	11:37367
199	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010576	MN -90i	11:38796
215	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010899	MN -90	11:37265
2063	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86006622	MN -90	11:37259
DOE/ID/12449-T1	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE86012055	MN -70B	11:37599
DOE/JPL/956289-86/1	NTIS, PC A05/MF A01 (GPO Dep.)	E 1.99: DE86012585	STD -63b	11:37733
DOE/JPL/956312-14	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86012138	MN -63b	11:37734
DOE/MA-0229	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99: DE86012460	STD -13	11:39429
DOE/MC/19314-11	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86012346	MN -90g	11:37368
12	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012347	MN -90g	11:37369
DOE/MC/20094-2031	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99: DE86001072	STD -93A	11:38137
DOE/MC/20122-2082	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99: DE86012686	STD -90b	11:37355
DOE/MC/20230-T3	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE85018325	MN -92a	11:37266
DOE/METC-86/0227	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99: DE86001027	STD -90	11:37260
86/0236	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86001071	STD -90e	11:37370
86/4064	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86006615	MN -92a	11:37429
DOE/NASA/1005-8	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86006660	STD -80	11:37947
DOE/NASA/50112-62-Rev.	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86011386	STD -96	11:38187
DOE/NBB-0078	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99: DE86011699	STD -11	11:38859
DOE/NBM-6011688	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE86011688	MN -28	11:37727
6012494	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86012494	MN -95d	11:38152
DOE/NE/44139-8	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86012253	STD -70	11:37600
DOE/NE/46640-16	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86011851	MN -70	11:37601
DOE/OR/20722-21	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99: DE86012601	STD -70A	11:37648
DOE/OR/20837-H1	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE86012981	MN -98	11:37382
DOE/PC/20103-T2	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE86007416	STD -90i	11:37385
DOE/PC/50001-T1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86011840	MN -90d	11:37386
DOE/PC/70507-T1	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99: DE86011633	MN -90g	11:38135
DOE/PC/70753-T7	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86012099	MN -90	11:37267
DOE/PC/70812-7	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86012288	MN -90d	11:37268
DOE/PC/70814-6	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99: DE86011868	STD -90d	11:37269
DOE/PC/73225-T2	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99: DE86007434	STD -90i	11:38797
DOE/PC/80512-T5	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86011990	MN -90i	11:37306
DOE/PC/80907-T2	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86012069	MN -90d	11:37270
DOE/PC/80913-3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86012939	MN -90a	11:37271
DOE/PC/81003-T2	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86010680	MN -90i	11:38531
DOE/PE-04505-1	NTIS$9.50			11:37493
DOE/R0/00650-T1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86012895	MN -95d	11:38153
DOE/RL/01830-H2	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86012638	MN -95	11:39430
DOE/RW-0040-Rev.	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009983	MN -70	11:37602
DOE/SF/00515-T64	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012315	MN -28	11:38682

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DOE/SSDC-					
76-45/ 27-2nd-Ed.	NTIS, PC A09/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011838	MN -41	11:38982
DOE/SSDP-					
0003	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011893	MN -78	11:37896
0004	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011892	MN -78	11:37897
0005	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011891	MN -78	11:37898
0006	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011890	MN -78	11:37899
0007	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011760	MN -78	11:37900
0008	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011895	MN -78	11:37901
0009	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011894	MN -78	11:37902
DP-					
1701-3	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86011668	STD -11	11:38786
1720	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86011912	STD -70	11:37603
DP-MS-					
85-113	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86004626	MN -70	11:37604
86-17	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010316	MN -70	11:37605
DPST-					
84-252	NTIS, PC A12/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010325	MN -11	11:38915
84-767	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011835	MN -11	11:37639
84-791	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011836	MN -11	11:38895
DTH-ABK-R-					
206	Danmarks Tekniske Hoejskole, Lyngby. Afdelingen for Baerende Konstruktioner			ND -25	11:38391
DTH-LV-MEDD-					
167	NTIS (US Sales Only), PC A12/MF A01; 1		DE86752095	MN -59B	11:37787
172	NTIS (US Sales Only), PC A04/MF A01; 1		DE86752097	MN -59A	11:37788
DTP-					
85/ 22	*See* DESY-85-101		DE86752070	MN -34D	11:39181
85/ 24	*See* DESY-85-133		DE86752075	MN -34D	11:39164
85/ 26	*See* DESY-85-134		DE86752074	MN -34D	11:39165
E-					
2536	*See* N-86-21578				11:38209
2761	*See* N-86-21577				11:37769
2808	*See* N-86-19008				11:39443
2905	*See* N-86-21658				11:38252
2942	*See* N-86-21978				11:38073
2956	*See* N-86-21635				11:38535
ECN-					
86-047	ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			ND -90i	11:37307
182	ECN, P.O. Box 1, 1755 ZG Petten, Netherlands		DE86752541	ND -34C	11:39204
ECS-SR-					
8	*See* DPST-84-252	E 1.99:	DE86010325	MN -11	11:38915
EER-Vent-					
84-6	*See* DOE/BP-00098-2	E 1.99:	DE86012269	MN -41	11:38793
EGG-					
2448	*See* NUREG/CR-4553		TI86013018	MN -41	11:38722
10282-2108	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012782	MN -92a	11:37473
EGG-M-					
10186	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011037	MN -95f	11:38193
11385-Rev.	Institute of Electrical and Electronics Engineers, 345 E. 47th Street, New York, NY 10017		TI86011051	ND -78	11:38020
12386	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011038	MN -70	11:37606
ENEA-RT-TIB-					
85/ 20	NTIS (US Sales Only), PC A03/MF A01; 1		DE86901545	MN -32	11:39301
EPA/450/4-					
86/ 001	*See* PB-86-192044/XAB				11:38821
EPA/520/5-					
85-026	NTIS, PC A16/MF A01		TI86901474	MN -11	11:37649
EPA/600/3-					
86/ 004C	*See* PB-86-187788/XAB				11:38811
86/ 029	*See* PB-86-194420/XAB				11:38824
EPA/600/D-					
86/ 079	*See* PB-86-191558/XAB				11:38820
86/ 081	*See* PB-86-190030/XAB				11:38885
86/ 082	*See* PB-86-191376/XAB				11:38819
86/ 093	*See* PB-86-190303/XAB				11:38817
86/ 098	*See* PB-86-193695/XAB				11:38974
86/ 100	*See* PB-86-195229/XAB				11:38825
EPA/600/J-					
86/ 022	*See* PB-86-187192/XAB				11:38972
86/ 023	*See* PB-86-185535/XAB				11:38971
86/ 033	*See* PB-86-190113/XAB				11:38973
86/ 036	*See* PB-86-190071/XAB				11:38813
EPRI-CS-					
4434	Research Reports Center, Box 50490, Palo Alto, CA 94303		TI86920353	ND -90b	11:37356
EPRI-EA-					
4543-CCM	Research Reports Center, Box 50490, Palo Alto, CA 94303		TI86920325	ND -11	11:37850
4544	NTIS, PC A10/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303 (GPO Dep.)	E 1.99:	DE86011642	MN -11	11:38878
4607	NTIS, PC A04/MF A01; 1 - Research Reports Center, Box 50490, Palo Alto, CA 94303 (GPO Dep.)	E 1.99:	DE86011649	MN -11	11:38879

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EPRI-EM-				
3287-CCM-Rev.2	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920354	ND -98F	11:38112
3978	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920349	ND -95d	11:38154
4616	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920350	ND -95f	11:38126
4628	NTIS, PC A06/MF A01; 1 - Research Reports Center, Box 50490, Palo Alto, CA 94303 (GPO Dep.)	E 1.99: DE86012795	MN -98	11:38127
4636	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920359	ND -96	11:38188
4659	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920355	ND -95d	11:38155
EPRI-NP-				
4498-Vol.2	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920345	ND -78	11:38021
4552	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920361	ND -78	11:37857
4582	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920316	ND -80	11:37994
4602	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920340	ND -78	11:37858
4615	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920362	ND -78	11:37951
4620	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920344	ND -78	11:37903
4622	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920341	ND -80	11:37995
4626	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920363	ND -78	11:37996
4627	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920335	ND -80	11:37997
ERA-				
79-0123	*See* ERATL-86/16/XAB			11:38194
ERATL-				
86/ 16/ XAB	NTIS, PC A$205.00/MF $205.00			11:38194
ESA-SP-				
33	NTIS, PC A12/MF A01			11:38737
40	NTIS, PC A11/MF A01			11:37728
ESA-TT-				
12	NTIS, PC A03/MF A01; original German version available from DFVLR, Cologne DM 15.50			11:38185
24	NTIS, PC A05/MF A01; original German version available from DFVLR, Cologne DM 21			11:38840
EUR-				
8800-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -90i	11:37308
9657/ I-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -25	11:38238
9932-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -38	11:38548
9951-FR	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -61A	11:37709
10080-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -38	11:38662
10088-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -38	11:38663
10144-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -95	11:38195
10290-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.		ND -98	11:37695
10304-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -95d	11:38156
FFAP-				
114	*See* STEV-VIND-86-2	DE86752280	MN -60	11:37823
FNAL/Pub-				
86/ 69-A	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012306	MN -34B	11:39017
86/ 71-A	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86012305	MN -34B	11:39018
86/ 81-A	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86012304	MN -34B	11:39019
86/ 83-A	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86012302	MN -34B	11:39288
FNAL-TM-				
1381-A	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86012597	STD -28	11:38688
1387	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86008121	STD -38	11:38549
1394	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010848	MN -11	11:37650
1400	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86012596	STD -34D	11:39131

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1402	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012599	STD -34D	11:39289
FOA-C-					
20591-E3	*See* STEV-VIND-86-3		DE86752281	MN -60	11:37824
FR-					
19009-1	*See* N-86-20495				11:38250
GA-A-					
16860-Vol.1	*See* SAND-83-7077-Vol.1	E 1.99:	DE86011660	MN -71	11:38554
16860-Vol.2	*See* SAND-83-7077-Vol.2	E 1.99:	DE86011661	MN -71	11:38555
18285-Add.	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011870	MN -62a	11:37738
18408	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012103	MN -77	11:37930
GAO/RCED-					
86-6	US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877		TI86901390	MN -11	11:37470
86-7	U.S. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877		TI86901428	MN -11	11:38920
86-63	US General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877		TI86901391	MN -11	11:38076
86-81FS	General Accounting Office, PO Box 6015, Gaithersburg, MD 20877		TI86901393	MN -11	11:38107
86-121	General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877		TI86901386	MN -41	11:38975
GJ/TMC-					
11	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86012078	STD -70A	11:37651
GKSS-					
86/ E/ 2	NTIS PC E02; Available from NTIS as TIB/B86-06434			ND -11	11:38896
GPO-					
4-080	GPO*				11:38108
5-987	GPO*				11:37948
GSF-					
41/ 85	NTIS (US Sales Only), PC A08/MF A01		DE86752085	MN -48	11:38947
GSF-S-					
1286	*See* GSF-41/85		DE86752085	MN -48	11:38947
GSI-					
85-64-Prepr.	NTIS (US Sales Only), PC A02/MF A01		DE86752079	MN -34C	11:39252
85-67-Prepr.	NTIS (US Sales Only), PC A03/MF A01		DE86752077	MN -34C	11:39259
85-69-Prepr.	NTIS (US Sales Only), PC A02/MF A01		DE86752078	MN -34C	11:39260
86-9-Prepr.	NTIS PC E02; Available from NTIS as TIB/B86-06551			ND -34C	11:39261
HEP-					
85/ 8	*See* DESY-85-134		DE86752074	MN -34D	11:39165
HMI-P-					
6/ 85-Prepr.	NTIS (US Sales Only), PC A02/MF A01		DE86752084	MN -34C	11:39247
IAEA-SM-					
286/ 6	*See* SAND-86-1295C	E 1.99:	DE86011646	MN -71	11:37524
286/ 88	*See* SAND-85-2206C	E 1.99:	DE86011647	MN -71	11:37656
286/ 92	*See* SAND-85-2208C	E 1.99:	DE86011648	MN -71	11:38556
286/ 96	*See* SAND-86-0054C	E 1.99:	DE86011180	MN -71	11:37523
286/ 213	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011752	MN -71	11:37520
IAEA-WMRA-					
16-Partial	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011273	MN -70	11:37607
IFE/KR/E-					
85/ 004	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752130	MN -97c	11:38239
IKU-P-					
112	NTIS (US Sales Only), PC A06/MF A01; 1		DE86752123	MN -92a	11:37474
IM-					
1964	*See* STU-83-5004		DE86752155	MN -25	11:38300
INDC(CPR)-					
003/ L	NTIS (US Sales Only), PC A02/MF A01		DE86701550	MN -46	11:39273
INDU/DC/GMH/TR-					
85-68	*See* AD-A-166015/8/XAB				11:39112
INIS-mf-					
9881	NTIS (US Sales Only), PC A09/MF A01		DE86752087	MN -4	11:38897
9883	NTIS (US Sales Only), PC A04/MF A01		DE86752076	MN -48	11:38948
9887	NTIS (US Sales Only), PC A05/MF A01		DE86752080	MN -11	11:38881
IS-M-					
565	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011434	MN -90i	11:37309
583	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011402	MN -90i	11:37310
584	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011403	MN -34	11:38403
IS-T-					
1177	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012673	MN -4	11:38491
1204	NTIS, PC A16/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012675	MN -90	11:37292
1227	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012671	MN -4	11:38470
ITA/OE-					
86/ 03	*See* PB-86-184660/XAB				11:37358
86/ 04	*See* PB-86-184686/XAB				11:37384
86/ 05	*See* PB-86-184652/XAB				11:37383
IVEM-					
5	Interfakultaire Vakgroep Energie- en Milieukunde RU, P.O. Box 72, 9700 AB Groningen, Netherlands			ND -61E	11:37697
JKF-D-					
540	*See* STU-83-5004		DE86752155	MN -25	11:38300
JTI-					
72	*See* STEV-BO-86-1		DE86752272	MN -61A	11:37742

Report Number	Availability Source	File Number		Distribution Category	Abstract Number
Jnel-					
1998	NTIS (US Sales Only), PC A08/MF A01		DE86752086	MN -25	11:38240
2023	NTIS PC E09; Available from NTIS as TIB/B86-05304			ND -80	11:37981
K/D-					
5622-Rev.1	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012615	MN -22	11:37509
KFK-					
3971	NTIS (US Sales Only), PC A06/MF A01		DE86752081	MN -25	11:38241
3976	NTIS (US Sales Only), PC A04/MF A01		DE86752083	MN -28	11:38714
3977	NTIS (US Sales Only), PC A02/MF A01		DE86752082	MN -34C	11:39212
KMSF-U-					
1757	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011862	MN -21	11:39312
1761	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011867	MN -21	11:38404
KTM/E-					
8421	NTIS (US Sales Only), PC A06/MF A01; 1		DE86752116	MN -90b	11:37357
KTM/E-B-					
54	NTIS (US Sales Only), PC A04/MF A01; 1		DE86752491	MN -98E	11:38206
KTM/E-D-					
91	NTIS (US Sales Only), PC A05/MF A01; 1		DE86752492	MN -90e	11:37371
KVL-JI-MEDD-					
52	NTIS (US Sales Only), PC A06/MF A01; 1		DE86752101	MN -61D	11:37710
L-					
16011	*See* N-86-20586				11:38251
16033	*See* N-86-21492				11:39030
16054	*See* N-86-20753				11:38534
LA-					
10262-M	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012765	STD -70B	11:37608
10573-MS	NTIS, PC A18/MF A01 (GPO Dep.)	E 1.99:	DE86012680	STD -70B	11:37640
10706-MS	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86011742	STD -11	11:38987
10730-MS-Vol.1	*See* NUREG/CR-4615-Vol.1		TI86011926	MN -70B	11:37642
LA-UR-					
85-4231	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86004728	MN -25	11:38242
86-796	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86007362	MN -25	11:38243
86-797	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86007361	MN -25	11:38244
86-1195	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012397	MN -28	11:38689
86-1394	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010196	MN -15	11:37670
86-1423	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010202	MN -34A	11:39072
86-1548	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011264	MN -93	11:38681
86-1565	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011263	MN -25	11:38393
86-1679	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011249	MN -34	11:39113
86-1744	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011218	MN -25	11:38394
86-1773	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012394	MN -28	11:38690
86-1813	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011240	MN -38	11:38550
86-1840	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011235	MN -93	11:38065
86-1943	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012383	MN -34A	11:39073
86-1975	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012380	MN -38	11:38752
86-1987	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012377	MN -28	11:38702
86-2000	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012376	MN -4	11:38526
86-2014	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012372	MN -38	11:38578
86-2032	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012371	MN -15	11:37671
86-2034	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012370	MN -2	11:39436
86-2044	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012368	MN -93A	11:38138
86-2045	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012415	MN -21	11:39362
86-2055	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012416	MN -34D	11:39132
86-2065	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86012414	MN -25	11:38245
86-2084	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012413	MN -38	11:38738
86-2088	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012411	MN -15	11:37672
86-2098	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012410	MN -34C	11:39207
86-2099	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012409	MN -15	11:37673
86-2108	NTIS, PC A02/MF A01 - GPO		TI86012408	MN -15	11:37674
86-2112	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012407	MN -38	11:38551
86-2122	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012405	MN -15	11:37675
86-2127	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012404	MN -90c	11:37272
86-2130	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86012403	MN -25	11:38353
86-2135	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012402	MN -34C	11:39184
86-2138	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012400	MN -34	11:38683
86-2157	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012398	MN -34D	11:38246
86-2158	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012446	MN -25	11:38405
86-2184	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012439	MN -97c	11:38062
86-2187	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012438	MN -15	11:37676
86-2189	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012437	MN -15	11:37677
86-2197	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012436	MN -34D	11:39133
86-2199	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012435	MN -25	11:38247
86-2214	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012432	MN -28	11:38703
86-2217	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012431	MN -34C	11:39262
86-2220	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012430	MN -16	11:38471
86-2232	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012429	MN -25	11:38406
86-2254	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012427	MN -38	11:38579
86-2255	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012426	MN -37	11:39279
86-2268	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012423	MN -38	11:38552
86-2282	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012420	MN -15	11:37678
86-2283	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012419	MN -34D	11:39134
LBL-					
16493	*See* DOE/BP-00098-2	E 1.99:	DE86012269	MN -41	11:38793

Report Number	Availability Source	File Number		Distribution Category	Abstract Number
19237	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011556	MN -95d	11:38157
19337	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012825	STD -95d	11:38158
19751	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86012681	MN -95d	11:38207
19752	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012759	MN -95d	11:38159
20180	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011923	MN -94a	11:38066
20288	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012011	MN -95d	11:38160
20863	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86007490	MN -34	11:38532
20878	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86007496	MN -90e	11:38212
20893	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012826	STD -38	11:38541
21030	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012821	STD -28	11:38704
21098	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012763	STD -95c	11:38128
21182	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012835	STD -28	11:38684
21184	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86012831	STD -93A	11:38139
21254	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011558	MN -66a	11:37810
21276	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011303	MN -38	11:38641
21287	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011308	MN -25	11:38248
21315	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012012	MN -25	11:38739
21318	NTIS, PC A11/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012830	STD -95d	11:38161
21336	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011561	MN -34C	11:39205
21340	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012682	MN -90d	11:37273
21355	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011553	MN -41	11:37311
21356	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011314	MN -25	11:38407
21372	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012013	MN -11	11:37312
21385	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011305	MN -34C	11:39253
21402	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012066	MN -34D	11:39135
21431	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011586	MN -25	11:38408
21436	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86012015	MN -34B	11:39020
21449	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012497	MN -38	11:38678
21452	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012019	MN -34C	11:39217
21468	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012495	MN -25	11:38249
21470	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011557	MN -25	11:39281
21548	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012018	MN -94	11:38067
21549	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012499	MN -28	11:38705
21604	NTIS, PC A02/MF01 (GPO Dep.)	E 1.99:	DE86011921	MN -34	11:38409
LITH-IKP-R-					
390	NTIS (US Sales Only), PC A04/MF A01; 1		DE86770099	MN -97b	11:38129
LITH-MAT-R-					
83-19	*See* LIU-TEK-LIC-1985-20		DE86770100	MN -13	11:38077
85-16	*See* LIU-TEK-LIC-1985-20		DE86770100	MN -13	11:38077
85-17	*See* LIU-TEK-LIC-1985-20		DE86770100	MN -13	11:38077
LIU-TEK-LIC-					
1985-20	NTIS (US Sales Only), PC A07/MF A01; 1		DE86770100	MN -13	11:38077
LIU-TemaV-RB-					
85-10	NTIS (US Sales Only), PC A06/MF A01; 1		DE86752141	MN -13	11:38097
LMSC-D-					
992164	*See* AD-A-166105/7/XAB				11:38733
LR-					
18(AP) M	*See* PB-86-182086/XAB				11:38803
534(AP) M	*See* PB-86-182854/XAB				11:38805
536(AP) M	*See* PB-86-182847/XAB				11:38804
LRP-					
289/ 86	NTIS (US Sales Only), PC A03/MF A01; 1		DE86901417	MN -20	11:39313
290/ 86	NTIS (US Sales Only), PC A04/MF A01		DE86901528	MN -20	11:39314
LUTVDG-TVTG-					
3009-1-94	NTIS (US Sales Only), PC A05/MF A01; 1		DE86752142	MN -66b	11:37811
MEA-					
2148-Vol.4	*See* NUREG/CR-3228-Vol.4		TI86901518	MN -78	11:37859
MHSMP-					
86-17	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012243	STD -11	11:37641
MIL-					
7-84	On loan from Risoe Library, DK-4000 Roskilde, Denmark			ND -11	11:38801
MLM-					
3342	NTIS, PC A02/MF A01; 1		DE86012246	STD -34A	11:38753
3348	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012262	STD -4	11:38516
MRI-					
86-1	*See* PB-86-191111/XAB				11:37496
MSHA/IR-					
1132	NTIS, PC A05/MF A01; 1		DE86901497	MN -41	11:38976
1143	NTIS, PC A14/MF A01; 1		DE86901492	MN -88	11:37337
1144	NTIS, PC A10/MF A01; 1		DE86901512	MN -41	11:38977
1145	NTIS, PC A12/MF A01; 1		DE86901511	MN -41	11:38978
1146	NTIS, PC A15/MF A01; 1		DE86901513	MN -41	11:38979
1147	NTIS, PC A04/MF A01; 1		DE86901493	MN -41	11:38980
1148	NTIS, PC A02/MF A01; 1		DE86901508	MN -88	11:38740
1149	NTIS, PC A02/MF A01; 1		DE86901509	MN -88	11:37387
1150	NTIS, PC A02/MF A01; 1		DE86901510	MN -88	11:37338
1151	NTIS, PC A03/MF A01; 1		DE86901501	MN -88	11:37339
1152	NTIS, PC A02/MF A01		DE86901500	MN -88	11:37340
1153	NTIS, PC A02/MF A01; 1		DE86901516	MN -88	11:37341
1173	NTIS, PC A19/MF A01; 1		DE86901502	MN -41	11:38981
N-					
86-19008	NTIS, PC A03/MF A01				11:39443
86-20495	NTIS, PC A09/MF A01				11:38250

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86-20497	NTIS, PC A08/MF A01				11:38354
86-20517	NTIS, PC A04/MF A01				11:38533
86-20518	NTIS, PC A02/MF A01				11:38525
86-20544	NTIS, PC A02/MF A01				11:38327
86-20586	NTIS, PC A02/MF A01				11:38251
86-20753	NTIS, PC A02/MF A01				11:38534
86-20995	NTIS, PC A04/MF A01				11:39021
86-20997	NTIS, PC A03/MF A01				11:38988
86-21297	NTIS, PC A02/MF A01				11:39203
86-21398	NTIS, PC A02				11:38553
86-21402	NTIS, PC A03/MF A01				11:38580
86-21475	NTIS, PC A02/MF A01				11:39022
86-21476	NTIS, PC A02/MF A01				11:39023
86-21477	NTIS, PC A03/MF A01				11:39024
86-21478	NTIS, PC A02/MF A01				11:39025
86-21479	NTIS, PC A02/MF A01				11:39026
86-21483	NTIS, PC A02/MF A01				11:39027
86-21486	NTIS, PC A02/MF A01				11:39028
86-21487	NTIS, PC A02/MF A01				11:39029
86-21492	NTIS, PC A03/MF A01				11:39030
86-21577	NTIS, PC A02/MF A01				11:37769
86-21578	NTIS, PC A03/MF A01				11:38209
86-21616	NTIS, PC A02/MF A01				11:38373
86-21635	NTIS, PC A02/MF A01				11:38535
86-21658	NTIS, PC A03/MF A01				11:38252
86-21791	NTIS, PC A02/MF A01				11:38751
86-21815	NTIS, PC A02/MF A01				11:38590
86-21817	NTIS, PC A05/MF A01				11:38664
86-21978	NTIS, PC A02/MF A01				11:38073
86-22451	NTIS, PC A05/MF A01				11:38355
86-22510	NTIS, PC A05/MF A01				11:39031
NASA-CR-					
174743	*See* N-86-21817				11:38664
175022	*See* N-86-20497				11:38354
175054	*See* N-86-22451				11:38355
176524	*See* N-86-21476				11:39023
176544	*See* N-86-21477				11:39024
176547	*See* N-86-21475				11:39022
176556	*See* N-86-21483				11:39027
176571	*See* N-86-21486				11:39028
176573	*See* N-86-20995				11:39021
176575	*See* N-86-21478				11:39025
176610	*See* N-86-21487				11:39029
176616	*See* N-86-21479				11:39026
176622	*See* N-86-22510				11:39031
177848	*See* N-86-21398				11:38553
177849	*See* N-86-20997				11:38988
NASA-TM-					
77871	*See* N-86-21616				11:38373
77983	*See* N-86-20544				11:38327
77999	*See* N-86-21815				11:38590
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2527	*See* N-86-21492				11:39030
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NBL-					
315	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012193	MN -15	11:37679
NBS/SP-					
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NBSIR-					
85/ 3256	*See* PB-86-189891/XAB				11:38168
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NE-					
01-86-KWIC-INDEX	Performance Assurance Project Office P.O. Box Y, Oak Ridge, TN 37831; 1		TI86012642	STD -80	11:37983
07-86-Master-Index	PAPO, ORNL, Building 9204-1, Rm. 321, PO Box Y, Oak Ridge, TN 37831		TI86012476	MN -80	11:37984
NE-E-					
13-16T-Rev.-1/ 86	Performance Assurance Project Office, ORNL building 9204, Rm. 32121 P.O. Box Y Oak Ridge, TN 37831		TI86012255	ND -79Te	11:37940
NE-F-					
9-4T-Rev.-2/ 84	Performance Assurance Project Office, ORNL building 9204, Rm. 321 P.O. Box Y Oak Ridge, TN 37831		TI86012478	ND -79Tk	11:37937

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14-2T-Rev.-1/ 86	Performance Assurance Project Office, ORNL Building 9204, Rm. 321, Box Y, Oak Ridge, TN 37831	TI86012475	ND -79Te	11:37939
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284052	NTIS (US Sales Only), PC A07/MF A01; 1	DE86752132	MN -11	11:38916
284142	NTIS (US Sales Only), PC A07; 3	DE86752133	MN -11	11:38917
284143	NTIS (US Sales Only), PC A10; 3	DE86752134	MN -11	11:38918
284144	NTIS (US Sales Only), PC A10; 3	DE86752135	MN -11	11:38919
NILU-OR-				
7/ 85	NTIS (US Sales Only), PC A04/MF A01; 1	DE86752313	MN -90i	11:38802
NIPER-				
138	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012582	MN -92	11:37430
150	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86012581	MN -92	11:37431
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195	NTIS (US Sales Only), PC A02/MF A01	DE86752494	MN -61F	11:37698
NMRDI-				
2-74-4614	NTIS, PC A07/MF A01; 1 - NMERDI Univ. of Nex Mexico, Suite M 457 Washington SE, Albuquerque, NM 87108	DE86901463	MN -98F	11:37706
NMRI-				
84-76	*See* AD-A-166343/4/XAB			11:38941
85-97	*See* AD-A-166012/5/XAB			11:38940
NP-				
6752098	NTIS (US Sales Only), PC A07/MF A01; 1	DE86752098	MN -38	11:38679
6752099	NTIS (US Sales Only), PC A05/MF A01; 1	DE86752099	MN -92	11:37478
6752102	NTIS (US Sales Only), PC A08/MF A01; 1	DE86752102	MN -98	11:38104
6752105	NTIS (US Sales Only), PC A03/MF A01; 1	DE86752105	MN -97e	11:37717
6752106	NTIS (US Sales Only), PC A08/MF A01; 1	DE86752106	MN -95d	11:38162
6752107	NTIS (US Sales Only), PC A09/MF A01; 1	DE86752107	MN -38	11:38677
6752108	NTIS (US Sales Only), PC A05/MF A01; 1	DE86752108	MN -95	11:38196
6752140	NTIS (US Sales Only), PC A06/MF A01; 1	DE86752140	MN -13	11:38078
6752267	NTIS (US Sales Only), PC A09/MF A01; 1	DE86752267	MN -94a	11:38068
6752268	NTIS (US Sales Only), PC A02/MF A01; 1	DE86752268	MN -60	11:37821
6752269	NTIS (US Sales Only), PC A07/MF A01; 1	DE86752269	MN -38	11:38680
6752316	NTIS (US Sales Only), PC A09/MF A01	DE86752316	MN -64	11:37818
6752472	NTIS (US Sales Only), PC A04/MF A01	DE86752472	MN -13	11:38189
6752496	NTIS (US Sales Only), PC A04/MF A01; 1	DE86752496	MN -98F	11:38079
6752497	NTIS (US Sales Only), PC A05/MF A01; 1	DE86752497	MN -61E	11:37699
6770110	NTIS (US Sales Only), PC A09/MF A01; 1	DE86770110	MN -92a	11:39003
6901446	School of Mines and Energy Development, Univ. of Alabama, Box 6282, University (Tuscaloosa), AL 35486	TI86901446	MN -11	11:38985
NPS-				
61-86-009	*See* AD-A-165878/0/XAB			11:38789
NRL-MR-				
5722	*See* AD-A-166431/7/XAB			11:39057
NRL-R-				
59	National Road Laboratory, P.O. Box 235, DK-4000 Roskilde, Denmark. Price: Dkr 100		ND -95e	11:38197
NRTC-				
83-25R	*See* AD-A-166114/9/XAB			11:38734
NTSB-PPS-				
80-1	NTIS$6.50			11:37498
NU-				
15/ 85	*See* OEFZS-4339		ND -48	11:38957
18/ 85	*See* OEFZS-4342		ND -11	11:38094
NUREG-				
1152	NTIS, PC A07/MF A01 - GPO	TI86901520	MN -78	11:38022
1177	NTIS, PC A12/MF A01 - GPO	TI86901533	MN -78	11:38023
1179-Vol.2	NTIS, PC A10/MF A01 - GPO	TI86901486	MN -41	11:37652
NUREG/BR-				
0051-Vol.7-No.6	NTIS, PC A03/MF A01 - GPO	TI86901542	MN -78	11:37856
NUREG/CR-				
3150	NTIS, PC A04/MF A01 - GPO	TI86901522	MN -11	11:38989
3228-Vol.4	NTIS, PC A10/MF A01 - GPO	TI86901518	MN -78	11:37859
3620-Suppl.1	NTIS, PC A09/MF A01 - GPO	TI86011529	MN -70	11:37653
4241	NTIS, PC A03/MF A01 - GPO	TI86012613	MN -78	11:38253
4507	NTIS, PC A17/MF A01 - GPO	TI86012875	MN -78	11:38024
4553	NTIS, PC A03/MF A01 - GPO	TI86013018	MN -41	11:38722
4588-Vol.3	NTIS, PC A05/MF A01 - GPO	TI86011100	MN -80	11:37998
4594	NTIS, PC A06/MF A01 - GPO	TI86012286	MN -78	11:38025
4609	NTIS, PC A04/MF A01 - GPO	TI86012649	MN -70	11:38990
4615-Vol.1	NTIS, PC A07/MF A01 - GPO	TI86011926	MN -70B	11:37642
4627	NTIS, PC A08/MF A01 - GPO	TI86901519	MN -2	11:37959
4632	NTIS, PC A04/MF A01 - GPO	TI86901521	MN -11	11:38991
4641	NTIS, PC A13/MF A01 - GPO	TI86901531	MN -70	11:39004
NWC-TP-				
6693	*See* AD-A-166408/5/XAB			11:37814
OEFZS-				
4339	Oesterreichisches Forschungszentrum Seibersdorf GmbH		ND -48	11:38957
4342	Oesterreichisches Forschungszentrum Seibersdorf GmbH		ND -11	11:38094

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ORNL-					
6179	NTIS, PC A05/MF A01 (GPO Dep.)	E 1.99:	DE86012039	MN -11	11:38898
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ORNL/CON-					
172	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012451	MN -95d	11:38163
ORNL/M-					
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2/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012534	MN -25	11:38255
3/ S1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012533	MN -25	11:38256
4/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012532	MN -25	11:38257
5/ S1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012531	MN -25	11:38258
6/ S1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012530	MN -25	11:38259
10/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012526	MN -25	11:38260
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15/ S1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012521	MN -25	11:38263
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18/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012518	MN -25	11:38265
19/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012517	MN -25	11:38266
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24/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012548	MN -25	11:38268
25/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012547	MN -25	11:38269
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27/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012545	MN -25	11:38271
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35/ S1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012537	MN -25	11:38279
36/ S1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012536	MN -25	11:38280
39/ S1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012561	MN -25	11:38281
43/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012557	MN -25	11:38282
44/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012556	MN -25	11:38283
46/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012554	MN -25	11:38284
47/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012553	MN -25	11:38285
48/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012552	MN -25	11:38286
49/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012551	MN -25	11:38287
50/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012550	MN -25	11:38288
51/ S1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012549	MN -25	11:38289
110	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012310	MN -23	11:38008
135	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011372	MN -11	11:38853
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79-42539/ 6	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012452	MN -95d	11:38164
79-42539/ 7	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012450	MN -95d	11:38165
80-7985/ 1	NTIS, PC A05/MF A01 (GPO Dep.)	E 1.99:	DE86012456	MN -95d	11:38166
85-22014/ 1	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012482	MN -95f	11:38198
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9429	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011374	MN -98F	11:38085
9833	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012635	STD -86	11:37512
9846-Vol.2	NTIS, PC A17/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012480	MN -70B	11:37609
9846-Vol.3-Pt.1	NTIS, PC A13/MF A01 (GPO Dep.)	E 1.99:	DE86012489	MN -70B	11:37610
9897	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012453	MN -96	11:38190
9936	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012589	MN -70	11:37611
9946	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012454	MN -90i	11:37313
10010	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012591	MN -28	11:38691
10042	NTIS, PC A06/MF A01 (GPO Dep.)	E 1.99:	DE86012457	MN -97b	11:37828
10070	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012606	STD -90d	11:37388
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86/ 21	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012186	MN -20	11:39329
86/ 22	NTIS, PC A02/MF A01; 1		DE86012198	MN -34	11:39123
OTA-ITE-					
300	*See* PB-86-182029/XAB				11:37393
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37	*See* PB-86-183597/XAB				11:38140
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4,589,113				11:38589
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86-177607/ XAB	NTIS, PC A08/MF A01			11:37778
86-177615/ XAB	NTIS, PC A08/MF A01			11:37779
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86-179199/ XAB	NTIS, PC A05/MF A01			11:39043
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86-180643/ XAB	NTIS, PC A03/MF A01			11:39044
86-182029/ XAB	NTIS, PC A09/MF A01			11:37393
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86-194420/ XAB	NTIS, PC A06/MF A01			11:38824
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86-195278/ XAB	NTIS, PC A06/MF A01			11:37275
86-195864/ XAB	NTIS, PC A02/MF A01			11:37344
86-196185/ XAB	NTIS, PC A06/MF A01			11:37501
86-196581/ XAB	NTIS, PC A02/MF A01			11:37345
86-197613/ XAB	NTIS, PC A04/MF A01			11:37497
86-197647/ XAB	NTIS, PC A04/MF A01			11:37502

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86-197654/ XAB	NTIS, PC A08/MF A01				11:37505
PFC/CP-					
86-7	*See* DOE/ET/51013-181	E 1.99:	DE86012256	MN -20a	11:39309
PFC/JA-					
86-33	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86011874	MN -20g	11:38581
PFC/RR-					
86-13	*See* DOE/ET/51013-184	E 1.99:	DE86012587	MN -20	11:39310
PITHA-					
84/ 17	NTIS PC E11; Available from NTIS as TIB/B86-06564			ND -34D	11:39147
PNL-					
4054-Suppl.1	*See* NUREG/CR-3620-Suppl.1		TI86011529	MN -70	11:37653
5687	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012082	MN -11	11:37613
5787	NTIS, PC A12/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012161	MN -70	11:37614
5817	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012295	MN -41	11:38886
5818	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012868	MN -94e	11:38069
5820	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86012633	MN -70	11:37615
5828	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012215	MN -70	11:37616
5831	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86012089	MN -41	11:38949
5864	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011706	MN -11	11:37617
5865	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011727	MN -11	11:37618
5880	NTIS, PC A13/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011717	MN -11	11:38101
5888	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86012222	MN -85	11:37654
PNL-SA-					
12297	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011608	MN -11	11:38902
13041	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012324	MN -95d	11:38171
13365	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011621	MN -70	11:37619
13430	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012151	MN -71	11:37521
13513	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011619	MN -20c	11:38291
13539	NTIS, PC A02/MF A01 - GPO		TI86011135	MN -11	11:38908
13541	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011624	MN -41	11:37655
13565	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012149	MN -63	11:37729
13584	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012150	MN -4	11:38472
13602	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012647	MN -34A	11:39075
13626	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011618	MN -41	11:38723
13632	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011132	MN -90i	11:38958
13672	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011623	MN -41	11:38724
13706	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011105	MN -95a	11:38086
13727	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012329	MN -79b	11:37936
13739	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012325	MN -95d	11:38172
13810	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011631	MN -85	11:37522
13816	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012332	MN -70	11:39005
13861	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011117	MN -11	11:38888
13897	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012146	MN -16	11:37680
13904	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012328	MN -95d	11:38173
13907	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011613	MN -70	11:38356
13913	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012326	MN -25	11:38292
13915	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012147	MN -62	11:38070
13941	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012327	MN -95d	11:38174
13968	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012148	MN -58	11:37730
13970	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012152	MN -90c	11:37276
14013	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012153	MN -92	11:37490
PSI-					
560/ SR-261	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011952	MN -95f	11:38141
PSR-					
1422-VOL-9	*See* AD-A-166282/4/XAB				11:38763
1422-VOL-10	*See* AD-A-166280/8/XAB				11:38762
R-					
468	*See* PB-86-187341/XAB				11:37389
497	*See* PB-86-185410/XAB				11:37612
RAL-					
85-094	*See* PB-86-180643/XAB				11:39044
85-115	Rutherford Appleton Lab., Chilton, Didcot, OXON, OX11 OQX, England		TI86901311	ND -34D	11:39167
REPT-					
1080	*See* N-86-20997				11:38988
63251-01-WR23	*See* PB-86-189008/XAB				11:37343
RFP-					
3878	NTIS, PC A02; 3		DE86009644	MN -41	11:38950
3936	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010807	MN -47	11:37620
3937	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010803	MN -70	11:37621
3962	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010808	MN -70	11:37622
4013	NTIS, PC A02; 3		DE86011855	MN -70	11:37623
RHO-PB-SR-					
10-B-CP-MAR.86	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011795	MN -2	11:37513
RISO-M-					
2555	NTIS (US Sales Only), PC A03/MF A01		DE86752266	MN -92a	11:37433
2562	NTIS (US Sales Only), PC A06/MF A01; 1		DE86752473	MN -60	11:37822
Risoe-M-					
2553	NTIS (US Sales Only), PC A06/MF A01; 1		DE86752096	MN -98F	11:38080
RR-WB-					
5-15	NTIS, PC A03/MF A01				11:37438
SAIC-					
84/ 1310	*See* AD-A-165794/9/XAB				11:38760

Report Number	Availability Source	File Number		Distribution Category	Abstract Number
SAND-					
83-7077-Vol.1	NTIS, PC A99/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011660	MN -71	11:38554
83-7077-Vol.2	NTIS, PC A21/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011661	MN -71	11:38555
84-0749	*See* NUREG/CR-4241		TI86012613	MN -78	11:38253
84-1439	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012085	MN -15	11:37681
84-1633	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012265	STD -45	11:38754
84-2620	NTIS, PC A18/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011768	MN -70	11:39006
85-0324	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012750	MN -70	11:37624
85-0970	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012634	STD -62a	11:37770
85-1053	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012732	MN -70	11:38787
85-1552C	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86004603	MN -38	11:38623
85-1813	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012608	MN -92	11:37483
85-2206C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011647	MN -71	11:37656
85-2208C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011648	MN -71	11:38556
85-2262C	NTIS, PC A02; 3		DE86005176	MN -38	11:38557
85-2509	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011702	MN -70	11:37643
85-2602	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012251	MN -70	11:38410
85-2628C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012165	MN -20c	11:39363
85-2748C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011643	MN -38	11:38645
85-2830C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012175	MN -25	11:38411
85-7223	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011995	MN -70B	11:37625
85-7226	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011823	MN -70	11:39013
85-7232	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011959	MN -70	11:39014
85-7233	NTIS, PC A09/MF A01 (GPO Dep.)	E 1.99:	DE86011961	MN -70	11:39015
85-7262	NTIS, PC A11/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012389	MN -70	11:37626
86-0004C	NTIS, PC A02/MF A01; 1		DE86010482	MN -62	11:37801
86-0021C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86006471	MN -38	11:38624
86-0033	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86006467	MN -34	11:38755
86-0039C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012174	MN -20a	11:39315
86-0054C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011180	MN -71	11:37523
86-0101	*See* NUREG/CR-4507		TI86012875	MN -78	11:38024
86-0158C	NTIS, PC A02; 3		DE86011185	MN -38	11:38625
86-0162C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011416	MN -34	11:38756
86-0237C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86007628	MN -25	11:39012
86-0244	NTIS, PC A12/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011962	MN -70	11:37627
86-0251C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86007627	MN -25	11:38293
86-0301C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012283	MN -38	11:38646
86-0434C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012282	MN -38	11:38647
86-0488	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012007	MN -70	11:37628
86-0512C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012279	MN -38	11:38648
86-0519C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012281	MN -38	11:38649
86-0567C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009023	MN -25	11:38294
86-0601	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012731	MN -32	11:39444
86-0609C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86008406	MN -25	11:38412
86-0629	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012041	MN -66	11:38993
86-0653C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012176	MN -15	11:37682
86-0654C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012177	MN -15	11:37683
86-0655C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011816	MN -15	11:37684
86-0662C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011650	MN -15	11:37685
86-0693C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012171	MN -15	11:37686
86-0702C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012172	MN -15	11:37687
86-0720	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012083	MN -70	11:37629
86-0749C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012162	MN -90c	11:37277
86-0779C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86008781	MN -25	11:38295
86-0784	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012077	STD -25	11:38392
86-0806C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009030	MN -25	11:38492
86-0812C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009284	MN -25	11:38296
86-0852	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011848	STD -62	11:37771
86-0865C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86011829	MN -11	11:38854
86-0921C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86009540	MN -34A	11:38741
86-0922	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012741	MN -25	11:38493
86-0938C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010097	MN -11	11:38994
86-0962C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009637	MN -20	11:39364
86-0975C	NTIS, PC A03; 3		DE86010468	MN -25	11:38297
86-1011C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012163	MN -38	11:38582
86-1032C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010459	MN -25	11:38473
86-1034C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010096	MN -70	11:39007
86-1104C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012170	MN -78	11:37860
86-1160C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010953	MN -38	11:38650
86-1240C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011826	MN -28	11:38685
86-1264C	NTIS, PC A03; 3 (GPO Dep.)	E 1.99:	DE86011645	MN -70	11:37644
86-1295C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011646	MN -71	11:37524
86-1321C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011653	MN -38	11:38542
86-1379C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012168	MN -38	11:38651
86-1412C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012169	MN -38	11:38626
86-1485C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012285	MN -13	11:39431
86-2035C	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010467	MN -63	11:37766
86-2061C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010989	MN -38	11:38558
86-2079C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010483	MN -38	11:38652
86-7031	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86012729	MN -63	11:37767
86-7083	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011594	STD -71	11:37525
86-7102C	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011424	MN -94cb	11:38074
86-8225	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86012610	MN -25	11:38494

Report Number	Availability Source	File Number		Distribution Category	Abstract Number
SAPR-					
4	*See* N-86-21476				11:39023
SAR-					
20	*See* N-86-20995				11:39021
21	*See* N-86-20995				11:39021
SBI-MEDD-					
56	Statens Byggeforskningsinstitut, P.O. Box 119, DK-2970 Hoersholm, Denmark. Price: Dkr. 51,25			ND -11	11:38826
SBI-R-					
162	Statens Byggeforskningsinstitut, P.O. Box 119, DK-2970 Hoersholm, Denmark. Price: Dkr. 63,75			ND -95d	11:38175
167	Statens Byggeforskningsinstitut, P.O. Box 119, DK-2970 Hoersholm, Denmark. Price: Dkr. 106,75			ND -95d	11:38176
176	Statens Byggeforskningsinstitut, P.O. Box 119, DK-2970 Hoersholm, Denmark. Price: Dkr. 61			ND -95d	11:38177
SERI/STR-					
211-2931	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010700	STD -63	11:37739
211-2932	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010699	STD -63	11:37740
SERI/TP-					
211-2960	NTIS, PC A02/MF A01; 1		DE86010702	MN -63	11:37741
232-2957	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010696	MN -61E	11:37703
252-2812	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86004424	MN -59B	11:37793
SERI/TR-					
252-2718	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86004448	MN -59A	11:37794
SGD-					
490-PT-2	*See* PB-86-179199/XAB				11:39043
SGP-TR-					
91	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010931	MN -66a	11:37815
SI-R-					
84325-1	NTIS (US Sales Only), PC A07/MF A01; 1		DE86752125	MN -92a	11:37475
800901-9	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752129	MN -48	11:38959
800901-11	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752495	MN -48	11:38960
830709-7	NTIS (US Sales Only), PC A02/MF A01; 1		DE86752122	MN -92a	11:37476
SIO-REF-					
86-12	*See* PB-86-189453/XAB				11:38992
SJF-Beretning-					
19	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752104	MN -95	11:38178
24	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752103	MN -95	11:38179
SLAC-PUB-					
3927	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011598	MN -28	11:38692
3957	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86011159	MN -28	11:38693
3961	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012044	MN -34D	11:39196
3974	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86012043	MN -28	11:38686
SLL-					
41	*See* STEV-TORV-86-5		DE86752276	MN -90a	11:37295
SLU-ISK-					
163	NTIS (US Sales Only), PC A05/MF A01; 1		DE86752143	MN -98	11:38105
SLU-IVL-					
174	*See* STEV-SB-86-7		DE86752485	MN -61	11:37745
SMHI-RMK-					
41	NTIS (US Sales Only), PC A02/MF A01; 1		DE86752270	MN -11	11:38827
SNIAS-					
52-430-101	NTIS, PC A02/MF A01				11:37434
SNV-					
3042	NTIS (US Sales Only), PC A03/MF A01		DE86752156	MN -11	11:38903
SOL-					
86-11	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86012158	MN -32	11:39445
STEV-					
1985-10	NTIS (US Sales Only), PC A06/MF A01		DE86752271	MN -98	11:38081
1986-1	NTIS (US Sales Only), PC A05/MF A01		DE86752480	MN -95	11:37831
STEV-EO-					
86-1	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752272	MN -61A	11:37742
86-4	NTIS (US Sales Only), PC A05/MF A01; 1		DE86752481	MN -61A	11:37743
STEV-FVE-					
86-1	NTIS (US Sales Only), PC A05/MF A01; 1		DE86752482	MN -94	11:38071
STEV-SB-					
86-2	NTIS (US Sales Only), PC A02/MF A01; 1		DE86752273	MN -69	11:38661
86-3	NTIS (US Sales Only), PC A06/MF A01; 1		DE86752274	MN -61A	11:37744
86-5	NTIS (US Sales Only), PC A04/MF A01; 1		DE86752483	MN -61	11:37712
86-6	NTIS (US Sales Only), PC A05/MF A01; 1		DE86752484	MN -95e	11:37713
86-7	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752485	MN -61	11:37745
86-9	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752486	MN -61D	11:37714
STEV-TORV-					
86-4	NTIS (US Sales Only), PC A04/MF A01; 1		DE86752275	MN -61A	11:37715
86-5	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752276	MN -90a	11:37295
86-7	NTIS (US Sales Only), PC A05/MF A01; 1		DE86752277	MN -61	11:37746
86-8	NTIS (US Sales Only), PC A05/MF A01; 1		DE86752278	MN -61D	11:37359
86-10	NTIS (US Sales Only), PC A08/MF A01; 1		DE86752279	MN -90	11:37261
86-11	NTIS (US Sales Only), PC A03/MF A01		DE86752487	MN -90b	11:37360
86-13	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752488	MN -90b	11:37361
STEV-VIND-					
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